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ABSTRACT

"Technology and Society: A Futuristic Perspective" is one of the "Preparing for Tomorrow's World" (PTW) program modules. PTW is an interdisciplinary, future-oriented program incorporating information from the sciences and social sciences and addressing societal concerns which interface science/technology/society. The program promotes responsible citizenry with increased abilities in critical thinking, problem-solving, social/ethical reasoning, and decision-making. In this module, students (grades 10-11) consider ways in which technology has changed our lives and anticipate future changes. Provided in the teaching guide are discussions of the socio-scientific reasoning model (theoretical basis of PTW); module overview (including purpose; strategies employed, focusing on the dilemma/debate discussion technique; module structure/objectives; and its use in the school curriculum) and suggested time schedule. Also provided are guidelines for conducting dilemma discussions (including basic steps in the process), a chart indicating moral issues (as defined by Kohlberg) presented in the dilemmas, and teaching strategies for each of the three module parts: examination of science/technology/society relationships, study of five technologies, and simulation of a future technology. A selected bibliography is also included. The module may be used as a separate unit of study, as a mini-course, or incorporated into existing social science, history, language arts, general science, or chemistry courses. (JN)

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PREPARING FOR TOMORROW'S WORLD

# TECHNOLOGY AND SOCIETY:
## A Futuristic Perspective

## Teacher's Guide

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Beacon City: An Urban Land-Use Simulation
Dilemmas in Bioethics
Technology and Society: A Futuristic Perspective

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PREPARING FOR TOMORROW'S WORLD

# TECHNOLOGY AND SOCIETY:
# A Futuristic Perspective

Teacher's Guide

Developed and Prepared by
Louis A. Iozzi, Director
Janey M.Y. Cheu, Associate Director
Nancy Brzezinski, Administrative Assistant

Institute for Science, Technology and Social Science Education
The Center for Coastal and Environmental Studies
Rutgers • The State University of New Jersey
Doolittle Hall
New Brunswick, New Jersey 08903

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**Asbury Park District**
• *Asbury Park High School*
Dolores Lynch, Joseph Manno, Thomas Sobieszczyk

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Stephen Bent, Stanley Cwiklinski

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Allen Dakin, Ronald DiGiuseppe, Thomas Ebeling, Chairperson, Science Dept., Paul Fessein, William Kester, Rilla Lee Kramer, Lester Gibbs, Kenneth Sullivan, Control Joseph DePuglio, Elmo Kirkland

**Hillsborough Township District**
• *Hillsborough School*
Jane Voss

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Louise Donnelly, Adele Hueston, John Ignacio, Science Coordinator

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William Harding, Patricia Larkin

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Judy Temkin

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Thomas Smith

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Joseph McKeon

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• *North Arlington High School*
John Bennett

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Lawrence Insley

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Edna Hudson, Trudy Iwanski, James Simes, Control Raymond Davis

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James Messersmith

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Jean Dorgan, Director of Instructional Development
• *South Brunswick High School*
R. Brian Biemuller, Robert Chopick, Chairperson, Science Dept., Terry Farinella, William Gray, Robert Johnson, Virginia Markham, Control George Blackburn, Karen Kozarski

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Francis Hobbie, District Curriculum Coordinator, Robert Joyce, Kenneth Kapperl, John Streko, Control Diane Bauman, Susan Chadwick, Vincent Domeraski, Carol Farrell, Philip Kinney, Richard Kleh, Anthony Martin, Judith Novack, David Weidemoyer, Louis Zarrello

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- Dr. Arthur W. Edwards, Chairman, Education Department
- Dr. William G. Smith, Assistant Professor
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## PREFACE

We live in an exciting, rapidly changing, and challenging world—a world highly dependent upon science and technology. Our world is changing so rapidly that we sometimes fail to recognize that much of what we today take for granted as common, everyday occurrences existed only in the imaginations of people just a few short years ago. Advances in science and technology have brought many dreams to fruition. Long before today's school children become senior citizens, much of today's "science fiction" will, in fact, become reality. Recall just a few accomplishments which not long ago were viewed as idle dreams:

- *New biomedical advances have made it possible to replace defective hearts, kidneys and other organs.*
- *The first air flight at Kitty Hawk lasted only a few seconds. Now, a little over half a century later space ships travel thousands of miles an hour to explore distant planets.*
- *Nuclear technology—of interest a few short years ago because of its destructive potential—could provide humankind with almost limitless supplies of energy for peace-time needs.*
- *Computer technology has made it possible to solve in seconds problems which only a decade ago would require many human lifetimes.*
- *Science and technology have brought us to the brink of controlling weather, earthquakes and other natural phenomena.*

Moreover, the changes which we have been experiencing and to which we have become accustomed are occurring at an increasingly rapid rate. Changes, most futurists forecast, will continue and, in fact, even accelerate as we move into the 21st Century and beyond. But, as Barry Commoner has stated, "There is no such thing as a free lunch." These great advances will not be achieved without a high price. We are now beginning to experience the adverse effects of our great achievements:

- *The world's natural resources are being rapidly depleted.*
- *Our planet's water and air are no longer pure and clean.*
- *Thousands of plant and animal species are threatened with extinction.*
- *Nearly half the world's population suffers from malnutrition.*

While science and technology have given us tremendous power, we are also confronted with an awesome responsibility: to use the power and ability wisely, to make equitable decision tradeoffs, and to make valid and just choices when there is no absolute "right" alternative. Whether we have used our new powers wisely is highly questionable.

Today's youth will soon become society's decision-makers. Will they be capable of improving upon the decision-making of the past? Will they possess the skills and abilities to make effective, equitable, long-range decisions to create a better world?

**To the student:**

This module has been prepared to help you—the student and future decision maker—function more effectively in a rapidly changing world. Other modules in the *Preparing for Tomorrow's World* program focus on additional issues of current and future importance.

**To the teacher:**

It is our belief that this module—and indeed the entire *Preparing for Tomorrow's World* program—will help you the teacher prepare the future decision-maker to deal effectively with issues and challenges at the interfaces of science/technology/society. It is our belief that the contents and activities in this program will begin to prepare today's youth to live life to the fullest, in balance with Earth's resources and environmental limits, and to meet the challenges of tomorrow's world.

Louis A. Iozzi, Ed. D.
Cook College
Rutgers-The State University of New Jersey

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# INTRODUCTION

In earlier times technology was greeted with awe and admiration. Engineering feats such as skyscrapers, bridges, tunnels, dams and so on stood as symbols of human ingenuity and power. In more recent years, the devastating capabilities of war armaments, the Three Mile Island incident, the Love Canal evacuation, the ban on cyclamates . . . have raised questions in the minds of people regarding the applications of science and technology. We are beginning to have misgivings and suspicions about the direction that technology is leading. The once held vision of science and technology providing solutions to our ills, be they social, political or economic, is being challenged. The more extreme critics of science and technology even suggest that many of our problems are the consequences of technology, and hence we would benefit by curbing the advance of technology, if not reverting to simpler lifestyles altogether.

But even if it were at all feasible, few of us would relish the thought of turning back to a totally primitive lifestyle. The very structure of our society is supported by the products of science and technology, and we, of course, enjoy the comfort and conveniences of our modern age.

Nonetheless, it is important to gain some perspective on the relationship among science, technology and the human experience, and perhaps even more so for our students who will be living in a world where technological innovations are introduced at accelerated rates. Given our encounters with negative consequences of technology we must begin to pose questions such as: How can we ensure our wise use of technology? How can we guard against inhumane use of technology? What new responsibilities are associated with new technological innovations? To what extent are we in control of our technology? The issues raised by these questions are complex and have no simple answers. Yet, these questions confront us, and in the process of examining these questions, our students may begin to gain a greater appreciation of their critical role as future decision makers who can influence technological innovation and change.

In this module, *Technology and Society, A Futuristic Perspective*, the concept of technology and change serves as the central theme. Technology is thus viewed, not as isolated feats, but in terms of how it has changed the way we live our lives — where we live, what we live in, what we eat and drink, how we work and what we must learn. From this perspective, the complexity of the technological process takes on larger dimensions, and students are introduced to the multiplicity of interactions that exist in the network. In the examination of technological change a variety of issues and problems emerge, many of which have no clear cut answers. Students, however, can begin to consider how technologies impact on social, economic and political systems in terms of advantages and disadvantages. As they examine such questions, it will become increasingly evident that technological advances bring about increased complexities that place new demands and responsibilities upon the public. The intent of this module is thus to impress upon students the importance of developing more effective decision making skills and scientific and social literacy. Provided in the materials are opportunities for students to share their ideas on a variety of questions regarding technological applications, examine the implications of emerging and future technologies from developments in biology to the physical sciences. Moreover, each topic can be examined from a personal, national, international and global perspective so that the broader as well as future consequences and impacts are considered.

Having gained a broader perspective of technology, our students, when they assume their adult roles, may be better able to make informed judgments on future developments.

## The Theoretical Basis of *Preparing for Tomorrow's World:*
## The Socio-Scientific Reasoning Model

As pointed out in the Introduction to this guide, developments in science and technology are not without societal issues and problems. New developments and applications will inevitably bring about new issues as well as increase their complexity. Unlike scientific problems, socio-scientific problems often have no "correct" answer because they involve human choices and decisions. Such choices and decisions are value ladened. The particular decisions made today and tomorrow will determine the course of the future. Hence, we are faced with the profound challenge to make just and wise decisions in order to create a better future world. To help prepare our students to become more effective problem solvers and decision makers, education will need to focus on the simultaneous development of the following skills:

- Ability to deal with problems containing multiple interacting variables
- Decision making that incorporates a wider social perspective
- Critical thinking in the evaluation of consequences and implications

### Components of the Socio-Scientific Reasoning Model

In response to the above concern and recognizing the importance of this mode of development, we developed the "socio-scientific reasoning" model to serve as a framework in the production of our curriculum materials. This model combines our own philosophy, ideas and research with the theories and philosophies of Piaget, Dewey, Kohlberg and Selman. Basic to these theories is the idea of education as helping an individual grow both intellectually and morally. Therefore, this socio-scientific reasoning model approaches education from a developmental perspective. This model incorporates the ideas of stage development from the perspective of cognition, moral ethical reasoning and social role taking. The basic tenets of these theories are briefly summarized below.

### Logical Reasoning

Jean Piaget, the noted Swiss psychologist, has made important contributions in the area of cognitive development which are pertinent to our efforts[1,2]. Piaget views the development of logical reasoning as progression through the series of stepwise stages indicated in Table 1 (sensori-motor, preoperational, concrete operational and formal operational). At each successive stage the logical reasoning ability of individuals takes on a broader perspective and incorporates the ability to deal with greater numbers of interacting variables of increasing intellectual complexity. Each stage of thinking builds upon the previous one, but takes on a new structural form. Growth in cognition, it seems, can be facilitated and nurtured through appropriate educational experiences.

In explaining growth in logical reasoning capability, Piaget refers to the processes of assimilation, accommodation, and equilibration. Assimilation occurs when the child incorporates new ideas and situations into his or her existing thought structures. On the other hand, the child also encounters objects and events that do not fit into his or her existing thought structures. In these contradictory situations, the child has essentially two options: he/she must either enlarge his/her existing structures or create a new category or structure. Piaget defines this as the process of accommodation.

Intellectual growth, Piaget postulates, occurs when the individual attempts to resolve the tension between the interactive processes of assimilation and accommodation by developing new thoughts and responses that are more suitable or adequate. Equilibrium is re-established when thought structures are altered, producing new accommodations that enable the individual to assimilate the new situations. Intellectual growth, then, occurs through internal self-regulation processes that lead to new, higher levels of equilibration.

### Moral/Ethical Reasoning

While there are several approaches to values education, the more encompassing one is the cognitive developmental approach offered by Lawrence Kohlberg[3,4]. Kohlberg's ideas are derived from the philosophic positions of Dewey and and Piaget. The emphasis here is to help individuals grow intellectually and morally. This is, we feel, a more functional approach than arbitrary indoctrination of values as used in "character" or "socialization" education or taking a "values relativity" stance, typically employed in the more common values clarification approach.

Kohlberg's moral/ethical development theory is an extension of Piaget's cognitive development theory. Similarly to Piaget, Kohlberg views moral development from childhood to adulthood as progression through a series of stages (Table 2). Each stage is characterized by a very different way of perceiving and interpreting one's experiences. At Kohlberg's Stage 2, for example, "right" and "wrong" are judged in terms of satisfying one's own needs and sometimes the needs of others if it is convenient to do so. Stage 3 type of reasoning centers around maintenance of approval in one's own social group. The orientation is towards conformity to group expectation. At the higher principled stages, reasoning takes into account concerns for the welfare of others in a broader context, and includes concerns for human dignity, liberty, justice, and equality—those very same principles upon which our Constitution is based.

Following Piaget, Kolhberg views development not as mere accumulation of information, but changes in thinking capabilities—the structures of thought processes. In the course of development, higher-level thought structures are attained and result in the extension of an individual's social perspective and reasoning capabilities. Applying higher levels of thinking to problems results in problem solutions that have greater consistency and are more generalizable. See Appendix detailing the stages of development.

### Social Role-Taking Stages

The research of Robert Selman[5] indicates that social role taking ability is a developed capacity which also progresses in a series of stages from early childhood through adolescence. Role taking is viewed by Selman in terms of qualitative

changes in the manner a child structures his/her understanding of the relationship between the perspectives of self and others.

Using the open-ended clinical method of inquiry first applied by Piaget and then later by Kohlberg, Selman has identified and defined Stages 0 through 4 (age range is approximately 3 years to 15+ years). These stages are referred to as: Ego-centric Viewpoint (Stage 0), Social-Informational Role Taking (Stage 1), Self Reflection Role Taking (Stage 2), Mutual Role Taking (Stage 3), and Social and Conventional System Role Taking (Stage 4). Descriptions of the role taking stages appear in Table 3. Each of Selman's role taking stages relates closely to and parallels Kohlberg's moral reasoning stages.

Selman views the social role taking stages as a link between Piaget's logical reasoning stages and Kohlberg's moral reasoning stages. Just as Piaget's logical reasoning stages are necessary but not sufficient for attaining the parallel moral reasoning stages, a similarly necessary but not sufficient relationship appears to exist between the social role taking stages and parallel moral reasoning stages.

As Selman has pointed out, ". . .the child's cognitive stage indicates his level of understanding of physical and logical problems, while his role taking stage indicates his level of understanding of the nature of social relations, and his moral judgment stage indicates the manner in which he decides how to resolve social conflicts between people with different points of view".

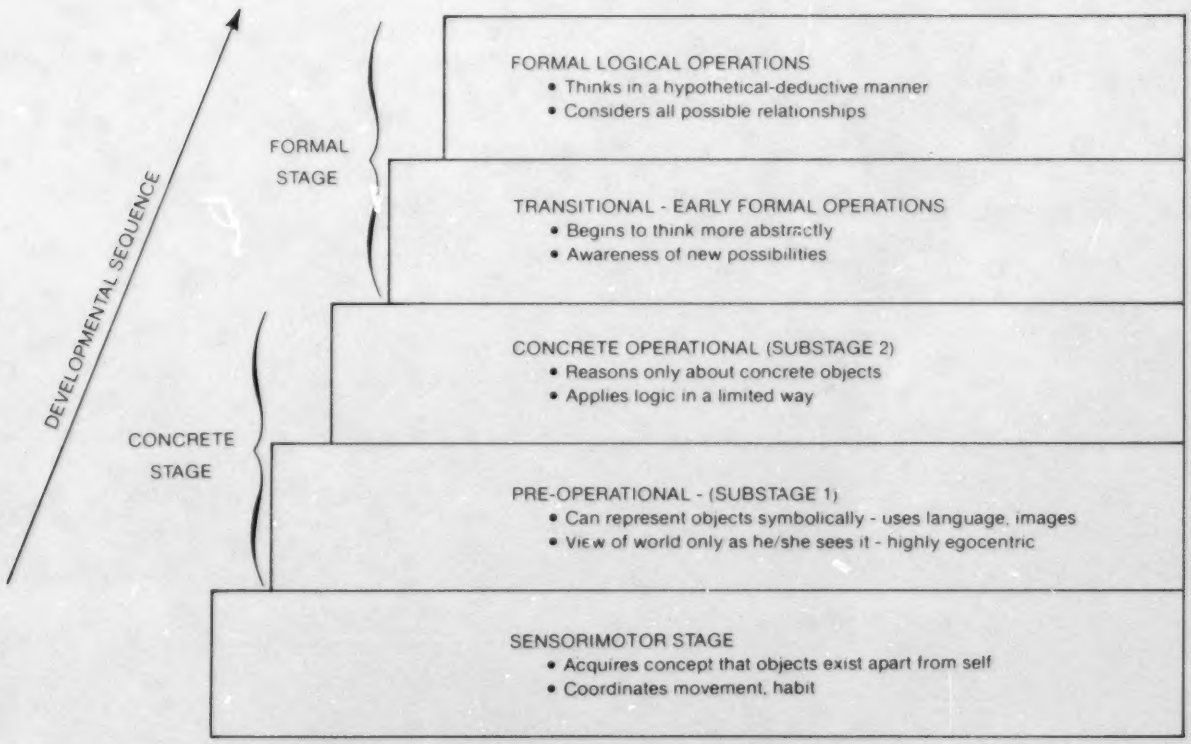
**The Socio-Scientific Reasoning Model**

Combining our own philosophy, ideas, and research with the theories of Piaget, Kohlberg and Selman, the socio-scientific reasoning model has been developed. Socio-scientific reasoning, as defined here, is the incorporation of the hypothetico-deductive mode of problem solving with the social and moral/ethical concerns of decision making. This model has served as a guide in the development of educational materials to help students advance to higher levels of thinking and reasoning capabilities. Moreover, it is highly flexible and readily adaptable to other classroom activities.

The basic assumption of this model is that effective problem solving requires simultaneous development in the realms of logical reasoning, social role taking, and moral/ethical reasoning. Purely objective scientific thinking cannot be applied in the resolution of most of the probable future conflicts without regard to the impact of those decisions on human needs and human goals. A technological solution, for example, may be, after critical analysis, feasible and logically consistent. From a societal perspective, however, one must question whether or not it should be applied. How to best prioritize our needs and evaluate trade-offs with a concern for the needs of future generations involves logical reasoning and critical thinking, but now with an added dimension . . . a social moral/ethical reasoning dimension.

Hence, the Socio-Scientific model consists of four interacting components (see Figure 1): (1) logical reasoning develop-

TABLE 1
PIAGET'S STAGES OF COGNITIVE DEVELOPMENT


DEVELOPMENTAL SEQUENCE
FORMAL STAGE
CONCRETE STAGE
FORMAL LOGICAL OPERATIONS
• Thinks in a hypothetical-deductive manner
• Considers all possible relationships
TRANSITIONAL - EARLY FORMAL OPERATIONS
• Begins to think more abstractly
• Awareness of new possibilities
CONCRETE OPERATIONAL (SUBSTAGE 2)
• Reasons only about concrete objects
• Applies logic in a limited way
PRE-OPERATIONAL - (SUBSTAGE 1)
• Can represent objects symbolically - uses language, images
• View of world only as he/she sees it - highly egocentric
SENSORIMOTOR STAGE
• Acquires concept that objects exist apart from self
• Coordinates movement, habit

ment is based on the theories of Piaget, while (2) moral/ethical reasoning relies strongly on Kohlberg's ideas. Selman's research provides the basis for the third component, the social role taking aspects of our model. Since the content or information component of the problem (component four) will vary, so too will the concepts vary accordingly. For example, in our applications of this model we have concentrated on issues at the interfaces of science, technology, and society. Of course, problem issues could also deal with or focus on any other topic one chooses to investigate.

The content component also consists of three interacting subunits. These subunits—science, technology, and society—rely on each other for their very existence. While each of the subunits is dependent upon the others, their individual underlying value structures create a high potential for discord since the concerns of one subunit often conflict with those of the

TABLE 2
KOHLBERG'S STAGES OF MORAL DEVELOPMENT

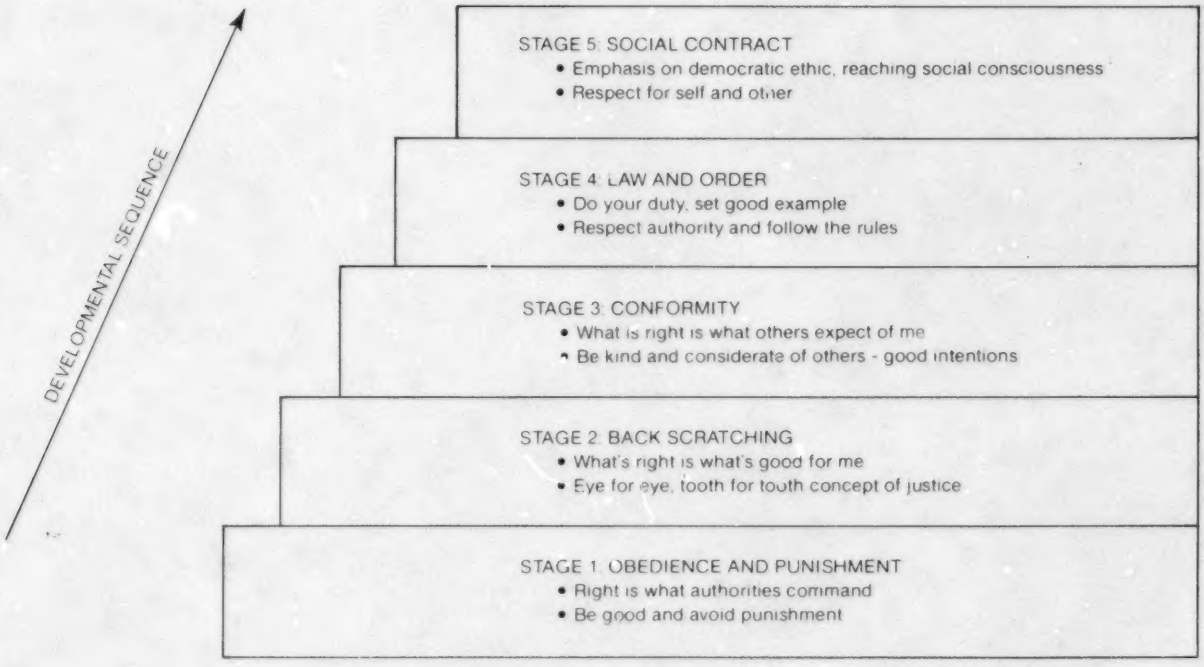

DEVELOPMENTAL SEQUENCE
STAGE 5: SOCIAL CONTRACT
• Emphasis on democratic ethic, reaching social consciousness
• Respect for self and other
STAGE 4: LAW AND ORDER
• Do your duty, set good example
• Respect authority and follow the rules
STAGE 3: CONFORMITY
• What is right is what others expect of me
• Be kind and considerate of others - good intentions
STAGE 2: BACK SCRATCHING
• What's right is what's good for me
• Eye for eye, tooth for tooth concept of justice
STAGE 1: OBEDIENCE AND PUNISHMENT
• Right is what authorities command
• Be good and avoid punishment

TABLE 3
SELMAN'S ROLE-TAKING STAGES

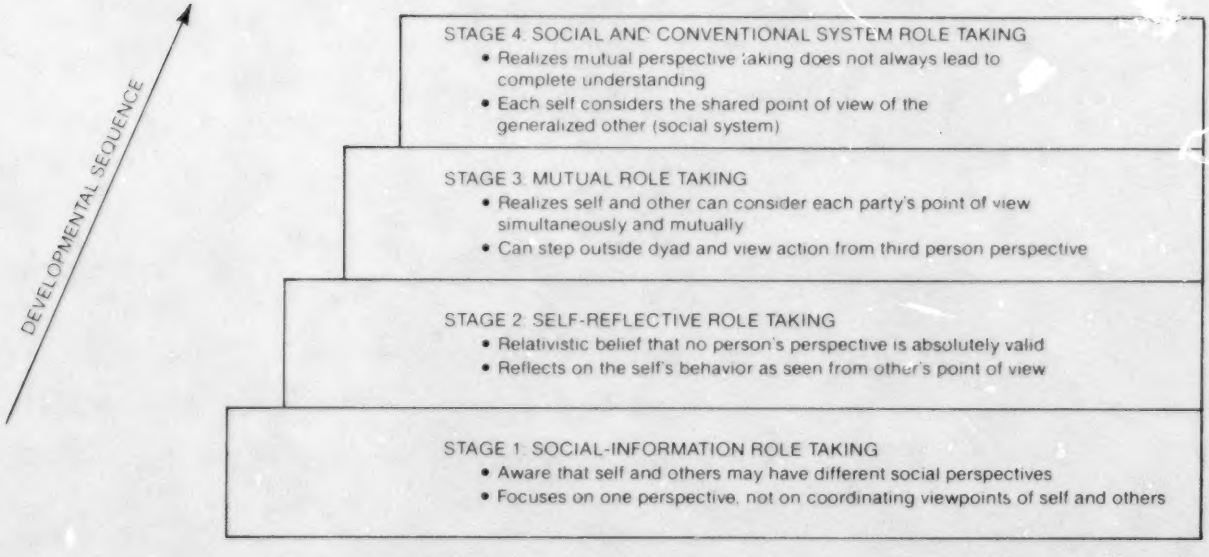
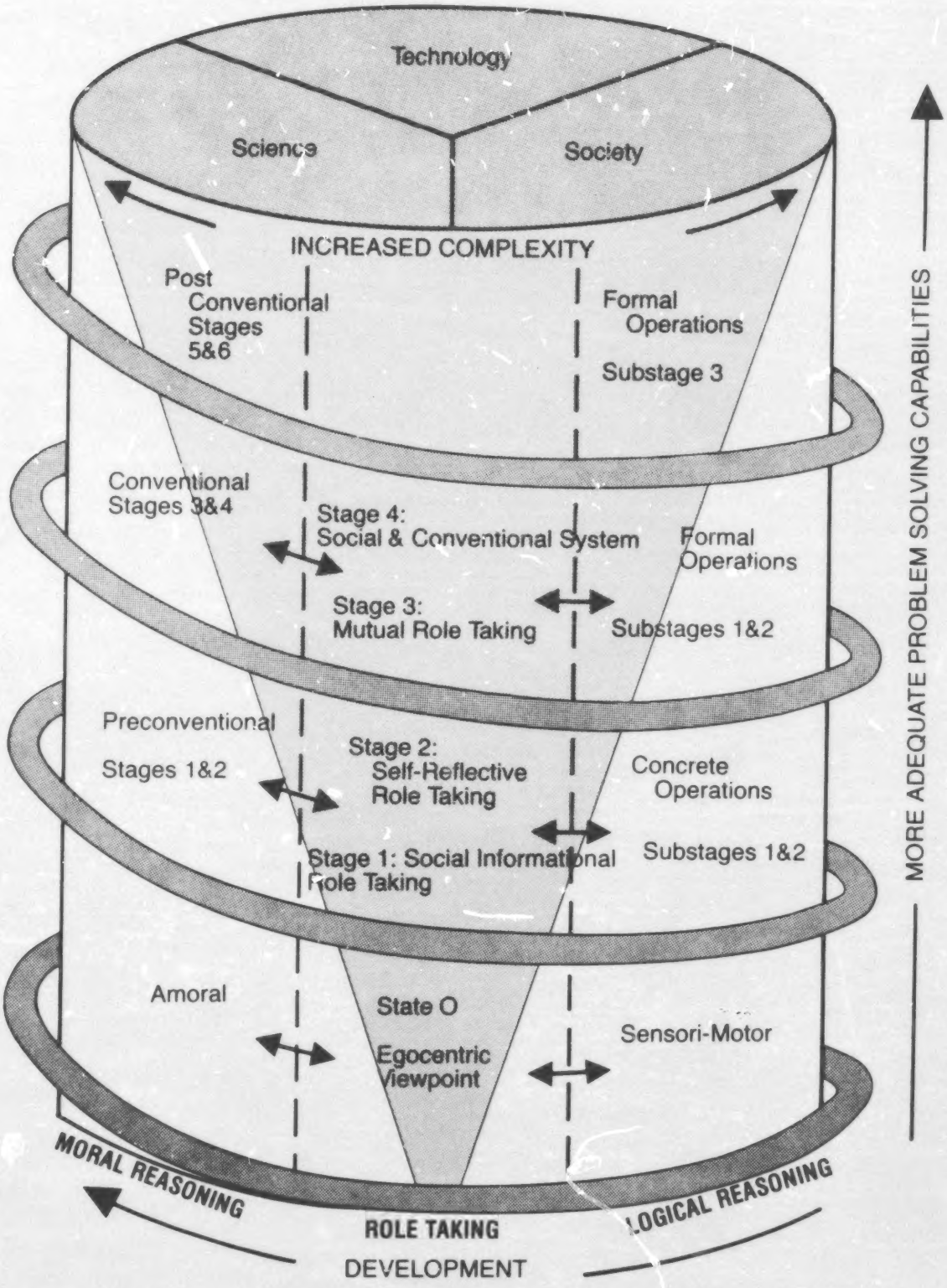

DEVELOPMENTAL SEQUENCE
STAGE 4: SOCIAL AND CONVENTIONAL SYSTEM ROLE TAKING
• Realizes mutual perspective taking does not always lead to complete understanding
• Each self considers the shared point of view of the generalized other (social system)
STAGE 3: MUTUAL ROLE TAKING
• Realizes self and other can consider each party's point of view simultaneously and mutually
• Can step outside dyad and view action from third person perspective
STAGE 2: SELF-REFLECTIVE ROLE TAKING
• Relativistic belief that no person's perspective is absolutely valid
• Reflects on the self's behavior as seen from other's point of view
STAGE 1: SOCIAL-INFORMATION ROLE TAKING
• Aware that self and others may have different social perspectives
• Focuses on one perspective, not on coordinating viewpoints of self and others

FIGURE 1

THE SOCIO-SCIENTIFIC REASONING MODEL



others. This paradox—dependence and simultaneous conflict among the subunits—presents a unique opportunity and context for curriculum developers employing the Socio-Scientific Reasoning model to prepare educational materials.

Each component of this model is not seen as a totally separate and distinct entity. Rather, each of the four components interacts with and has an effect on all other components. Thus, logical reasoning has an effect on, and in turn is affected by, social role taking development. In a similar manner, social role taking has an effect on, and is affected by, developments in the moral/ethical realm. Of course, logical reasoning and moral/ethical reasoning also interact. Each of these major components—logical reasoning, social role taking, and moral/ethical reasoning—interact not only with each other but with the fourth component, content or information.

Referring to Figure 1 again, the content cone is small at the low end because at earlier stages of development the number of concepts entertained are smaller and the concepts are simple in nature. Hence, as the cone broadens so too does the complexity of content or information included. Individuals at stages of development intersecting the lower end of the cone can deal with issues and concepts of a simpler form while, on the other hand, individuals at the upper end with higher levels of maturity have the capacity for dealing with more issues and issues of greater complexity. Development, then, is both vertical and horizontal: vertical development is from lower to higher stages; horizontal development relates to the "necessary but not sufficient" requirements which must be satisfied as one moves from logical reasoning, through social role taking, to moral reasoning capabilities.

Thus, while each stage reflects a distinctly unique capability for problem solving in a science/technology/society context, we view development or progress as a continuously spiraling process. In this process, however, there are leaps and quiesence, and fixation at any stage is possible. Levels of logical reasoning, moral reasoning, and role taking maturity also seem to vary, we find, depending on the issues addressed. These apparent inconsistencies in reasoning—even when dealing with the same or similar mental and moral constructs—seem to be related to the degree of emotionality, familiarity with, interest in, and/or knowledge about the issues under consideration[7].

The goal then is to help each individual "spiral" upwards through the Socio-Scientific Reasoning cone and synchronously achieve "more adequate" problem solving capability. "More adequate" as used here refers to the idea that when applied to problem solving, the higher stages of reasoning result in solutions that are more encompassing and generalizable; they enable students to deal with greater complexity.

**Application of the Socio-Scientific Reasoning Model in the Classroom**

The Socio-Scientific Reasoning model therefore serves as the basis for identifying the types of learning experience and the sophistication level of those experiences important to help students develop. It recognizes that learning capabilities differ with age, grade level, interest and learning needs. Implicit in the model and in accord with stage theory is the idea that at each stage there is a characteristic form of thinking capability which determines how experiences and information are interpreted and acted upon.

The main strategy underlying all of these activities is based on Piaget's concept of equilibration. It is only when disequilibrium is created that active restructuring of thought takes place. This active restructuring leads to growth in logical reasoning, in social role taking, and in moral/ethical reasoning capabilities as well.

Restructuring of existing cognitive structures occurs when internal disequilibrium is felt by the individual. New experiences and inputs which are not readily comprehensible to the individual challenge his/her existing mode of thought by revealing inadequacies or inconsistencies in that problem solving strategy[8]. Arrestment at a given stage is partially explained by the developmental theorists as the lack of opportunities that create conflict or dissonance which place the individual in a position where he/she needs to assess his/her particular mode of thinking. Perhaps, as Clive Beck points out, the reason why people do not develop morally is because they have not had the opportunity to entertain alternatives—their imaginations have not been extended[9]. We, in addition, contend that the reason people do not advance in logical reasoning can also be attributed, to a large degree, to a similar lack of opportunities.

We have identified some of the basic elements needed to provide experiential opportunities that promote development of problem solving and decision making skills. A partial listing includes providing opportunities for students to:

- Encounter a variety of viewpoints
- Experience higher level reasoning
- Take the perspective of others
- Examine and clarify one's own ideas
- Examine the consequences and implications of one's decisions
- Defend one's position
- Evaluate possible alternatives
- Consider and recognize the role of the self to society
- Reflect on one's own value system
- Test own ideas and those of others

One educational activity which incorporates some of these elements is the classroom dilemma discussion, an activity most commonly associated with Lawrence Kohlberg and his colleagues. We have, however, modified and extended this approach to more systematically encompass critical analysis and evaluation of information and data. We have also employed such other formats as role taking, simulations, and futures forecasting and analysis methodologies.

For example, reasoning at a particular stage is not a value judgment of whether an act is good or bad, but is the pattern of the concepts entertained in judging the "ought" of rights, duties and obligations of human relationships. Younger children at lower stages reason about duties in terms of reciprocal benefits from the party—"If you do me a favor, I will do you a favor." Whereas in principled reasoning, duty is what an individual has become morally committed to do and is self-chosen. Higher stage reasoning is therefore the ability to apply value concerns (Kohlberg's major concerns include self welfare, welfare of others, sense of duty and of motives, conscience, rules, punitive justice, role taking) in a more

internalized, complex, autonomous, critical, consistent and generalized manner.

Effective discussion, however, cannot take place in a vacuum. Needed also is an information base or context from which students can begin to analyze and evaluate information. With information which they have extracted and synthesized, additional ideas and rational arguments can be developed for discussion. For curriculum activities, we have created problem situations in a variety of contexts which, according to scholars in a variety of fields, will be prominent in the next quarter century and beyond[10]. This adds another perspective to the dilemma problem—that which elicits scientific logical reasoning in addition to moral/ethical reasoning—but in a futuristic context.

These serve as mechanisms for students to put some of the ideas and judgments that have emanated from the discussion into larger structural frameworks. They also provide students with opportunities to project into the future, to think beyond their own immediate experiences, and to consider the impact of different decisions on future society.

[1]Jean Piaget. Piaget's theory. In Thomas Lickona (Ed.) *Charmichael's manual of child psychology*. New York: John Wiley and Sons, 1970.

[2]Howard E. Gruber and J.J. Vonèche. *The essential Piaget*. New York: Basic Books, Inc., 1979.

[3]Lawrence Kohlberg. Moral stages and moralization: the cognitive-development approach. In Thomas Lickona (Ed.) *Moral development and behavior: theory, research, and social issues*. New York: Holt, Rinehardt and Winston, 1976.

[4]John Gibbs, L. Kohlberg, A Colby and B. Speicher-Duban. The domain and development of moral judgment. In John R. Meyer (Ed.) *Reflections on values education*. Waterloo, Ontairo, Canada: Wilfred Lawrier University Press, 1976.

[5]Robert Selman. Social-cognitive understanding: a guide to educational and clinical practice. In Thomas Lickona (Ed.) *Moral development and behavior: theory, research, and social issues*. New York: Holt, Rinehardt and Winston, 1976.

[6]Ibid, pg. 307.

[7]Louis A. Iozzi. *Moral judgment, verbal ability, logical resoning ability and environmental issues*. Doctoral Dissertation, Rutgers-the State University of New Jersey, 1976.

[8]Carol Tomlinson-Keasey and Clark B. Keasey. The mediating role of cognitive development in moral judgment. *Child Development*, 1974, *45*, 291-298.

[9]Clive M. Beck. *Ethics*. Toronto: McGraw-Hill, 1972.

[10]Harold G. Shane. *Curriculum change toward the 21st century*. Washington, D.C.: National Education Association, 1977.

## OVERVIEW OF *Technology And Society, A Futuristic Perspective*

### Purpose

This module is designed to engage students to examine some of the ways in which technology has changed our lives and to anticipate future changes. Associated with various technological applications are issues and problems arising in the scientific, social, economic and political domains. Many of these impacts are long range, subtle, and exert influence distant from their point of use. In some cases, these impacts may have consequences thousands of years hence. A prime example is the hazard of storing waste plutonium which has a radioactive half-life of 2400 years. By posing dilemmas and problems associated with new technological developments, students can gain an increased awareness of the variety of considerations that should be taken into account when a new technology is offered. The particular decisions made, policies enacted and actions taken can bring about untold benefits, new hazards or radical changes in the course of human affairs. In addition, the impact of new technologies cannot be completely anticipated, and hence students need to learn to be open to never before considered possibilities — to think creatively and at more abstract levels.

Through critical analysis of current and future possibilities, it is hoped that students will become wiser, more effective decision makers — decision makers with an expanded vision and the ability to analyze effects beyond those which are local in scope, serving one's personal self-interest. In this way, perhaps, today's glaring newspaper headlines reporting hazards and societal dislocations that result from our technology can be averted in the future.

### Strategy

The concepts presented in this module are complex. Moreover, the very idea of change is foreign to most students because they have experiences spanning less than two decades and because change is so very imperceptible as we live our daily lives. We have thus used a variety of strategies, namely dilemma discussions, debates, role playing and simulations, to heighten the issues and problems. In these more concrete situations, students can actively participate in the exploration of the concept. Hence, they will begin a seemingly simple activity at a level they can readily comprehend, but as they pursue the questions in great depth, more sophisticated concepts are entertained. The levels of complexity attained will of course depend upon the student's degree of involvement and interest.

In the course of conducting this module, you will no doubt find opportunities to pursue other aspects of the issue and create extension activities. As discussed in the theoretical section of this guide, students need experiences that challenge their existing ideas in order to develop higher order mental structures. Such experiences are gained through dynamic dialogue with other classmates. Several of the activities place students in adversary positions or in role positions that do not reflect their personal perspectives. This is done intentionally to create opportunities for students to constructively argue with one another and with themselves. In some cases the situation may appear to be an artificially heightened controversy, but given the complexity of the issue, it becomes necessary to use an apparently straightforward, simple conflict as an initial starting point. Each student should thus be able to grasp the problem and investigate it at the level of complexity consistent with his/her mental sophistication.

If students have had few experiences with the open-ended activities and discussions characteristic of this module, they may experience some degree of discomfort. They will pursue you for the "correct" answers, where in fact there are none, or seek your opinion. Once they recognize your role as a dispassionate observer, they will quickly resort to their own resources and begin to make decisions on their own. This has been verified time and again by teachers who field tested these materials. They find that students are willing and anxious to express their ideas and opinions once they realize that they can do so in a nonjudgmental, non-threatening atmosphere. The earlier activities in this module tend to be more structured than the subsequent ones so that students are gradually guided to think independently and make their own decisions. The strategy of small group discussion and group planning also provides a supportive atmosphere for the more reticent student.

It is our belief that understanding problems/issues and formulating one's own ideas requires a knowledge base as well as a sense of personal involvement. Introductory information is provided through articles and commentaries. Additional knowledge is acquired as students begin to think about and discuss ideas in the several types of activities and decision making opportunities. For the most part, opposing sides of the issues are included in order that students can reflect upon and question the wisdom of a given choice or action. Some of the readings may appear to be rather lengthy. They are included to serve more as reference material offering a variety of ideas for students to develop their own arguments or opinions. Students may wish to skim an article first and then refer back to it as needed during the course of the discussion or activity.

The dilemma debate/discussion constitutes a major type of activity in this module. It serves as an effective vehicle to focus on and heighten issues and to actively involve students in the dialogue. Some of the dilemmas are adopted from actual case histories while others, although hypothetical, reflect critical choices that are being made today or will need resolution in the foreseeable future. The simulation and role play activities are variations of this basic format.

The dilemma debate/discussion format has been selected as the focal point of classroom activity for several reasons:

- The highly controversial problem situation quickly generates differences of opinion among students.
- Students become actively involved in the dialogue.
- Students are exposed to alternative ideas or positions so that they often need to re-examine their own positions.
- Students learn to support their position in a well-thought out and logical manner.

During the course of discussion, students will experience ethical or value conflict. When the implications and consequences of certain decisions are examined, the outcome may in fact be in opposition to what the student originally thought to be desirable. It is through the process of experiencing conflict that students develop new ways of thinking about problems and their solutions. Also, students may find arguments presented by their peers more relevant to them than those they read or hear from adult authority. Although it may seem that students learn less factual information from discussion than from lectures or readings, the discussion process places a personal demand on students to synthesize, organize, and interrelate information and concepts. In this way, they are, in fact, developing higher order skills that, unlike recall of factual material, do not readily decay with time.

While the dilemma situations involve individuals, we have constructed them to reflect decisions having effects at the personal, community, national and global levels. Hence, students can begin to extend their thinking when they consider those effects from a variety of perspectives. In view of developmental research findings that place senior high school students at Piaget's transition stage to formal logical reasoning, many of the dilemmas require that students consider the social implications of decisions beyond their own social sphere to those which reflect more global concerns. The intention is to move students from egocentric thinking to thinking more broadly.

The dilemmas, as presented, are simple in form. It is through in-depth discussion that they grow in complexity. This is where skillful interjection of questions is so important. Your role as teacher/facilitator becomes critical because your insights help to stimulate new ideas and perspectives on the issue. The way in which students explore the dilemmas will, of course, depend upon their intellectual and conceptual level as well as their interest and curiosity. Also, the subject area in which the module is taught will influence ways in which concepts may be further developed — such as concepts from sociology, economics, ecology, civics, philosophy, history, etc. Drawing relationships from what is learned in the course will inevitably make students' learning more meaningful and effective.

**Technology and Society: A Futuristic Perspective in the School Curriculum**

This module designed for the senior high school level (grades 11 and 12) may be used in a number of subject areas: science, sociology, history, language arts, etc. The types of issues and concepts emphasized will depend upon the particular course and its focus. The materials allow for a high degree of flexibility. For example, in a science class, greater emphasis may be placed on exploring the process of scientific research and the question of scientific responsibility. In a sociology class, greater emphasis may be placed examining how emerging technologies may change the role of workers and job opportunities.

Students and teachers have found, in using these materials, that the dilemma discussions and other activities often suggest alternative dilemmas or additional activities. So often it is the case that many of the best dilemmas are developed spontaneously during the course of study. Having employed dilemma discussion and recognizing the value of this type of discussion, one begins to recognize a vast array of other problematic situations that will stimulate lively discussion.

By continually relating topics studied in class to current and future concerns of society, students can better appreciate the applicability of their studies. The question of "Why should I learn this?" can be easily answered when students recognize the many diverse types of problems encountered in a highly technological society and the difficulty of finding solutions that will please everyone. Hopefully, students will recognize that advances in science and technology require higher degrees of literacy in order to make informed and wise decisions, whether it be in their personal lives or in public policy making. The decision-making activities in this module thus offer a variety of opportunities for students to apply and interrelate what they have learned.

**Objectives of the Module**

- To increase students' knowledge about issues that interface science, technology, and society, now and in the future.
- To increase students' ability to analyze issues that arise in our technological society.
- To increase the socio-scientific reasoning ability of students.
- To increase students' decision making skills.
- To develop students' awareness of their role in the process of technological change.
- To help students recognize the complexity of decision making in our technological society.
- To provide opportunities for students to examine possible future technologies and societal changes.
- To increase students' ability to recognize the impact and effects of different types of decisions.

- To increase students' ability to develop and present effective arguments in a logical, comprehensive manner.
- To enable students' to more critically examine their value systems.
- To increase students' ability to communicate and function more effectively in classroom discussions.

**Components of Technology and Society: A Futuristic Perspective**

- Student's Textbook
- Teacher's Guide
- Student Handouts — 4

**Technology and Society:** *A Futuristic Perspective* is comprised of three major sections. Section I guides students to examine the dynamic relationship that exists between science, technology and society. In the several activities and role play simulations students consider the many different ways in which technology has effected changes in all realms of human activity. The underlying concept is that the application of a given technology does not exist in isolation, but profoundly influences our thinking, behavior and activities. Moreover, while new innovations are intended to extend human capabilities, they also create new challenges. An important question that emerges from this section is "What knowledge and skills are necessary for citizens to function effectively in our highly technological society?"

Section II examines five technologies of our time and presents potential societal conflicts that might arise in their applications. The topics are introduced through readings and the conflicts or issues are presented in the form of dilemmas for student discussion. The dilemma heightens the underlying socioscientific issues of the controversy and raises questions of a moral/ethical nature. They illustrate the fact that the moral/ethical implications of technology are factors that need to be taken into account in decisions about how technology should be used. Moreover, advances in science and technology often raise new moral questions that society has never before encountered. Each dilemma situation asks students to decide what the central role character should do and to supply reasons for taking a particular action. Following each dilemma is a series of probe questions to help stimulate discussion as well as to bring out other aspects and implications of the situation. Each of the dilemma stories raises two or more moral issues. Table 4 identifies the issues emphasized in each of the dilemmas. Become familiar with the issues so that you can help students focus on the crux of the conflict.

Section III is a simulation which offers students an opportunity to select technologies for the future. The technology assessment concept is used as the format for this exercise to guide students to consider the multiplicity of factors involved in the decision making process. This simulation also provides students an opportunity to apply and integrate ideas that they gained from prior activities of the module.

This module is designed for a high degree of flexibility. The activities may be presented in the order given and serve as a single unit of study or in an order that would best relate to ongoing classroom studies. The dilemma discussions may follow directly one after another or used selectively with time intervals between each dilemma. Thus, the module can provide another dimension to the existing course or "stand on its own" as a mini course.

**Table 4**
Issues Contained in Each Dilemma

| | Dilemma | Issues* | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | punishment/blame | property | affiliation role | law | life | truth | governance | civil rights/ social justice | morality/mores |
| 1 | Perfecting Human Nature | | | | | | X | | X | |
| 2 | An Infinite Source of Energy | | | | X | | | X | | |
| 3 | So Human an Animal | | X | | | X | | | | X |
| 4 | Is Winning Everything? | | X | | X | | | | | |
| 5 | The Wiser One? | | | | | X | | X | | |

*These basic moral issues as identified by Kohlberg comprise the underlying elements of a conflict situation involving a moral decision. Our dilemmas were constructed to incorporate two or more of these issues. Dilemma resolution requires a choice or action to be made between conflicting issues. For instance, in a dilemma dealing with the issues of governance and social justice, the questions surrounding the issue of governance include: 1) Should one accept or reject the authority of the governing body? 2) What are the characteristics and responsibilities of good government? The social justice issue raises the questions: 1) How should one protect the political, social and economic rights of another person? 2) What are the bases of these rights?

**Suggested Time Schedule**

Class Meeting — Student Activity

1. Activity 1: Complete Handout 1, *Technology Inventory*
2. Small group discussion of Activity 1
3. Read The Industrial Revolution in the Home and prepare resumes for Activity 2
4. Activity 2, Part 2. Role Playing the Job Interview
5. Activity 3. Read *The Unseen Cost of Nuclear Power and the Faustian Bargain* and small group meetings to complete Handout 2, *Technology, Consequences and Responsibilities.*
6. Group reports and class discussion of Activity 3.
7. Activity 4. Prepare for class debate.
8. Class Debate
9. Complete class debate and discussion of issues raised in the debate.
10. Discussion of Dilemma 1*
11. Discussion of Dilemma 2*
12. Discussion of Dilemma 3*
13. Discussion of Dilemma 4*
14. Discussion of Dilemma 5*
15. Introduction of Activity 5 and group meetings
16. Student research
17. Group meetings, Handout 3, Technology Assessment Worksheet
18. Group meetings
19. World Review Court Hearing, Handout 4, World Review Court Evaluation Sheet.
20. World Review Court Hearing and Debriefing
21. Scenario Writing
22. Presentation of scenarios

*It is advisable to allow some time interval between dilemma discussions so that the activity does not become redundant. Consider also some of the different ways to provide variety to the discussion format suggested in this teacher's guide.

## Conducting Dilemma Discussions In The Classroom

Since dilemma discussion may be a new classroom technique, its major characteristics, the basic guidelines, and some helpful suggestions will be described. There are no hard, fast rules for leading dilemma discussions. Most important is that both teacher and students feel comfortable participating in the activity. The following guidelines are merely recommendations drawn from experiences of persons who have conducted moral dilemma discussions in the classroom. These may or may not meet the entire requirements of your particular situation and needs. Adjustments and changes may be necessary so that the dilemmas and discussion format correspond to the intellectual level and interests of your students.

**Basic Steps in the Process**

The five basic steps in conducting a dilemma discussion as outlined by Kohlberg and his associates are as follows:

*Presentation of the dilemma*
*Selection of alternative positions*
*Small group discussions*
*Class discussion*
*Summary and closing of discussion*

**Background Information** — In our materials we have included an additional component — an information base. See Diagram 1, *Schema for Dilemma Discussion*. This background information will provide students with at least a basic understanding of the issues contained in the dilemma and therefore the substantive content which can be used to develop the discussion. Moreover, the background materials serve to bridge the gap between the real world and the hypothetical dilemma situation. Hence, the dilemma will be construed not simply as a story, but as a reflection of real societal concerns and value moral conflicts that arise from our scientific technological activities. Readings or other activities should therefore stimulate thinking and assist students in the formulation of their personal views regarding the action that the main character(s) in the dilemma should take.

The background information provided is by no means extensive, and you may find it desirable to include additional materials as the need arises. If you have readings or exercises which you feel are more suitable for your students, do not hesitate to substitute or supplement what has been included here. In addition, it may be necessary to discuss in class some of the more sophisticated concepts and technical terminology to insure that students have an understanding of the basic issues.

Our desire is to avoid encumbering students with too much technical detail and information. Nonetheless, some classes may wish to pursue certain topics in greater depth and should be encouraged to do so. From our experience, additional research on the part of the students helps to generate a livelier discussion that includes a wide diversity of perspectives.

Following each dilemma are a series of questions. These questions can serve to probe further into the issue or provide the basis for developing other dilemmas. The dilemmas, as presented, focus on a limited instance but, as educators are well aware, issues have many more ramifications and can be built upon to encompass a much more complex situation. Therefore, by proceeding from a simple situation, it is possible to increase the levels of complexity in a step-wise fashion with appropriate questions.

Provocative questions can also help students reflect on how they might be affected by certain decisions or policies and their roles as future decision-making citizens.

**Presentation of the Dilemma** — After the students have read the introductory material as a classroom or homework assignment, the dilemma can be presented. The dilemma may be read to the class as a whole, or else, each student can read the dilemma for himself/herself. At this point you may wish to determine if the students fully understand the dilemma. This can be identified by asking:

- Do you feel that this is a hard question to answer?
- Will someone please summarize the situation?
- What things might the main character have to consider in making a choice?
- What are the main points in the conflict?
- Who would be primarily affected by the decision?

**Small Group Discussion** — It is usually recommended that dilemma discussions be first conducted in small groups followed by discussion with the entire class. Students often are more willing to speak out in small rather than large groups. It offers individuals greater opportunity to speak out as well as places more responsibility on each person to contribute to the group's activities. The sense of informality in a small group allows for entertaining unique or unusual ideas that students may hesitate to bring up in a larger grouping for fear of ridicule or "put-downs."

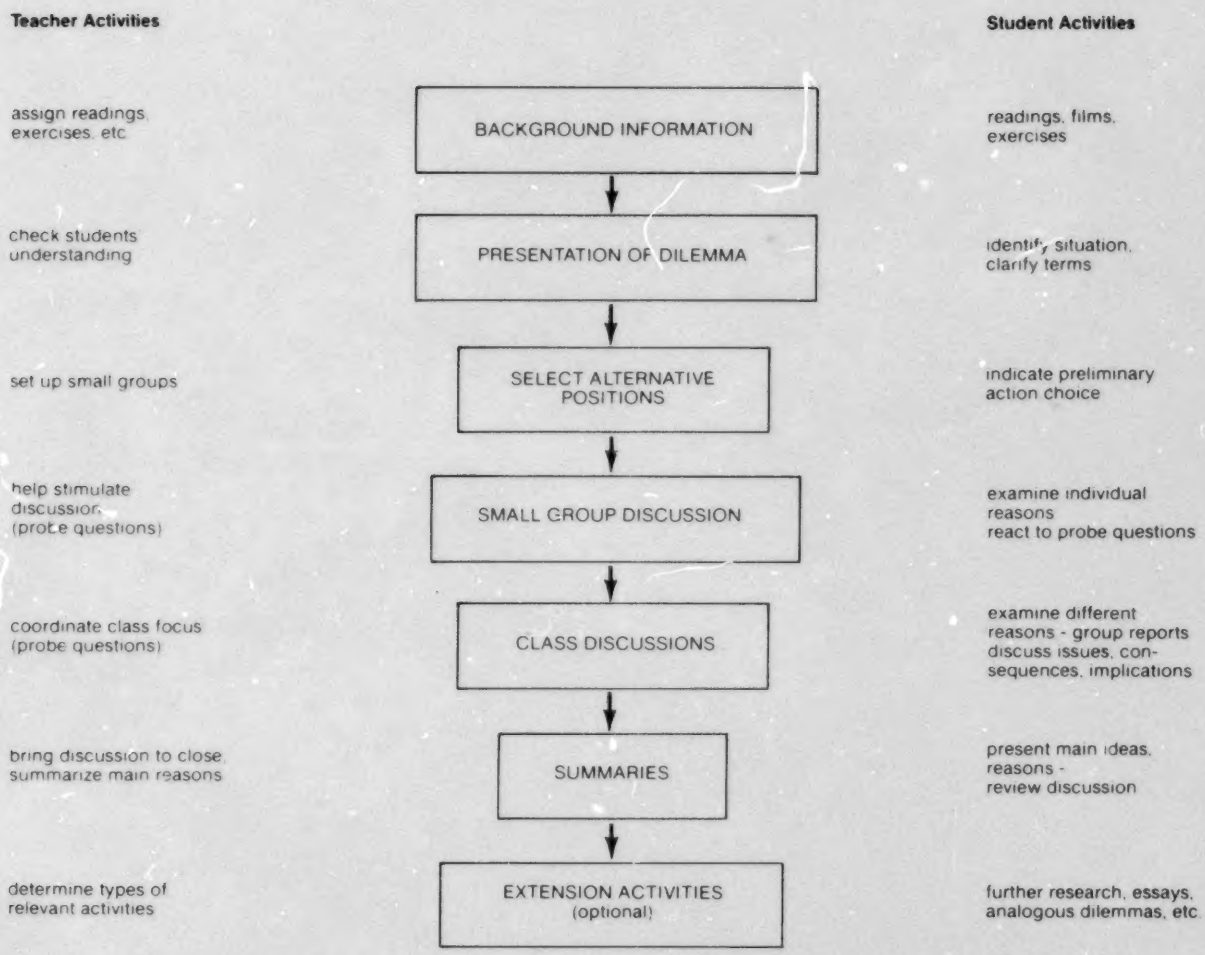
**Homogeneous Grouping** — The small discussion groups (four to six students) may be formed in a number of ways. From a show of hands or written answers students who vote "yes" or "no" on the question can be identified and grouped according to their position. There should be enough heterogeneity among class members to create division the question and formation of the small discussion groups.

Small groups where members hold similar positions would provide a more congenial atmosphere for initiating discussion. Here the students will feel less threatened if their peers share the same action decision and be more willing to contribute to the conversation. The membership would be more supportive, and individuals would not sense a fear of attack or failure.

**Heterogeneous Grouping** — In another format, students may be arbitrarily grouped. Here they have the additional task of evaluating, analyzing, criticizing and challenging the reasons given in the alternative choices. In this approach the degree of controversy is heightened, creating the potential of generating a livelier exchange. In defending a particular choice, the student will need to come up with more convincing reasons in order to persuade the others to support his/her side. Or the group might begin by using a "brainstorm" session and generate a series of supporting reasons for the different positions. These responses can then be examined and compared with one another. Through an elimination process, the group can select the more compelling arguments for each position.

DIAGRAM 1

## SCHEMA FOR DILEMMA DISCUSSION




Whatever grouping strategy you decide to employ, all the groups should focus on the moral issues of the dilemma. To more personally involve students in the group discussion have them first express their feelings about the dilemma. Some preliminary questions for consideration might include:

- What issues in the dilemma are hard to talk about? What makes them difficult to discuss?
- Can you foresee yourself having to make such a decision?
- Do you know anyone who has had to make a similar decision?
- Have you recently read any news articles about similar dilemmas?
- How do you think you would feel if you had to make such a decision?
- When you have a problem, how do you think it through?

Once the students become comfortable with the discussion format, they can then begin to critically discuss the position taken and the supporting reasons. They should consider the adequacy of the reasons given as well as the adequacy of their own reasons. After stating, comparing and evaluating each of the reasons, they might select two or three of those that they believe best support the position taken on the dilemma issues. Each of the dilemmas contains two or more major moral issues. It is important that the students recognize the issues within a dilemma and direct their attention to the issues and not to the irrelevant aspects of the dilemma (i.e., speculating on the reality of such a situation).

If a group has difficulty in getting started or if discussion begins to lag, the teacher can interject a probe question or two to activate conversation. (See the discussion below on the different types and uses of probe questions.) Sample probe questions are listed at the end of each dilemma and may be used selectively as needed. It is often useful to have students answer a few of probe questions as a written assignment prior to the group discussion. In this way, students have time and opportunity to reflect on the issues and become more constructive contributors to the dialogue.

A recorder should be selected to list the group's conclusion to be presented in a written or verbal form for the entire class discussion.

**Class Discussion** — The entire class reconvenes to hear the comments made in the various groups. The discussion results of each of the groups are presented for the entire class to examine. They might be best displayed on the chalkboard or overhead projector. This procedure presents the opportunity for students taking opposing views to ask questions and challenge the different viewpoints. Again, the adequacy of the reasons are critically analyzed and merits of each discussed. Students reasoning at lower levels will be exposed to higher level reasoning and discover that their reasons may not have taken wider implications into consideration and hence be less appropriate for resolving the conflict.

The class as a whole can then choose the best reasons for each position. You will find that although students may not be able to generate higher level reasons they will tend to prefer reasons one stage higher than their own.

The class discussion is most fruitful if the discussion guides students to explore ideas they have not considered and to think about those higher level reasons. This can be accomplished through the use of probe questions. There are basically seven types of probe questions:[1]

1 *Clarifying probe:* Asking student to explain what he/she means in his/her statement. "What do you mean when you say that concealing evidence is immoral? What is the meaning of *immoral?*"

2 *Perception checking probe:* Determining whether student understands a statement made by another individual. "Please explain to me what Joe has just said."

3 *Issue specific probe:* Examining student's thinking on the major issues (Kohlberg has identified ten that underlie moral reasoning — see Table 4). "Why should the government establish standards for air quality? What should good guidelines take into account?" (Issues: governance and law)

4 *Inter-issue probe:* Resolving conflict when two or more issues appear to be at odds. "Should a richer country be allowed to use a greater share of the earth's resources?" (Issues: social justice, life, property)

5 *Role switch probe:* Placing student in the position of someone involved in the dilemma. "What would you do if you had to make that decision?"

6 *Universal consequences probe:* Considering the implication of the judgment made when applied to everyone. "What might happen if every household were required to reduce its use of electricity by 30%? Is it fair to place such demands on everyone?"

7 *Reason seeking probe:* "How did you come to this conclusion?" or "Why?"

Questioning along these lines will lead students to broaden their scope of thinking and to evaluate effects and consequences of different solutions. It offers them an opportunity to see how others might think about the same issue and challenges them to consider the many sides of an issue.

Probe questions can also be used to develop alternative dilemmas or introduce more abstract ideas by increasing the complexity of the dilemma. For instance, a dilemma involving personal sacrifices in a gasoline rationing situation might be extended to consider social and life-style changes in our highly mobile society. How should transportation fuel be best allocated? Does private and public interest conflict if gasoline were rationed? Dilemmas of an inter-personal nature can thus be presented from a community, national or even inter-global perspective to stimulate thinking about future implications for human society.

Skillful questioning becomes the tool to aid students to think critically — analyzing the positions they take and the values inherent in their position. They should begin to discover the significance of their principles by relating those principles to specific decisions and situations. Is government severely limiting our freedom of choice when it enacts safety regulations? What should freedom mean? What is the relationship between freedom and responsibility? What should be the role of government in protecting the health and welfare of future society? The constant interplay between the abstract principles concepts and specific instances is pertinent in making the dialogue a thoughtful, meaningful exercise. Students need to understand concepts on their own terms before they can integrate new concepts and ideas into their thought structure. The process of development is one where students actively experience (or think about) new ideas which in turn interact in restructuring the form of thinking.

Discussion should also include analysis of the information and facts given. How does the information influence the decision? What is inferred from the information presented? Were the facts provided sufficient for informed decision making? What additional information is desirable? How might one go about acquiring additional knowledge? On what basis does one sort out and analyze the facts given? To what degree does the information influence the decision towards one position or another?

Finally, the consequences and implications must be appraised. This is the test of the effects of the position taken; again values are weighed. What values are held? What makes them desirable? What are the priorities? How is the nature of human society perceived?

**Closing the Discussion** — The discussion can be closed with a simple summary statement of the major points made. This summation will help the student bring together the ideas entertained during the discussion into sharper focus. One approach is to write down the list of the major reasons/arguments "pro" and "con". The reasons most preferred by the students can be indicated, or the reasons can be rank ordered.

The different positions on the dilemmas should not be judged for that would imply a correct answer. A "right" answer would also defeat the purpose of future discussions; students will try to "second guess" the optimum position response. However, at this time the students should have another opportunity to choose reasons they personally prefer or find most persuasive. This decision need not be openly declared. Suggest that the students examine their original reasons after hearing the other comments. What might they wish to change or add?

It may be appropriate at this time to point out some actual situations that resemble the hypothetical dilemma. How were they resolved and what were some of the results? Students may begin to notice analogous dilemmas that are currently making the news headlines. It is a good idea to take every opportunity to relate concepts discussed in class to the students' personal experiences and levels of interest.

**Some General Guidelines for Dilemma Discussion**

Dilemma discussions should flow naturally and comfortably. However, when students have had little exposure to open-ended types of discussions, it is often difficult to engage them in in-depth exploration of an issue. The following are some pointers that might be useful in stimulating discussion.

***Goals of Moral Discussion*** Barry Beyer, who has written extensively on moral discussion techniques, has pointed out that the goals of moral discussion should contribute to the overall objectives of the course and general educational goals, in addition to introducing new ones. Hence these goals are general rather than narrow in nature. Among these are: 1) improving learning skills, 2) improving self-esteem, 3) improving attitudes toward school, 4) improving knowledge of key concepts, and 5) facilitating stage change.[12]

An important teaching strategy is to encourage students to think about and reflect on alternatives and consider different ideas. The process of development includes extending one's imagination and exploring one's thinking.[13]

***Classroom Atmosphere*** Every effort should be taken to create an atmosphere conducive to an open, free exchange of ideas. Students should feel at ease when expressing their thoughts and, when confronted with challenge, not feel that they are being attacked personally. The emphasis is on analyzing the reasoning process by considering divergent viewpoints and alternative choices. It would be stressed that no one answer is correct or absolute; each position has merits and invites investigation.

Classroom furniture should be arranged in such a way that students can speak directly with one another and can be easily heard. For small group discussions the chairs might be arranged in a number of small circles so that attention can be given to all members of the group with-out delineating an authority focal point. The seating should also offer some degree of flexibility so that students might be able to shift groups or share their thoughts with members of other groups. A student who is uncomfortable with one group or who wished to take the opposing position may want to move to another group.

***Role of Teacher*** The teacher's crucial role in dilemma discussions is that of a creative process facilitator whose function is to stimulate students' searching and "stretching," and help students embark on their own personal search. A key skill lies in sensitive listening. By listening with care and delaying action the teacher can begin to:

- Identify problems that students may have in coming to grips with the issues—do the questions need further clarification?
- Identify students who monopolize or dominate the conversations;
- Find students who are hesitant in expressing their ideas;
- Prevent the discussion from becoming a clash of personalities;
- Find when the discussion begins to lag or focuses on irrelevant details, etc.

By posing questions to the group or certain group members, the teacher can then provide helpful guidance or gently direct the course of the discussion.

At all times it is important that the teacher be supportive and reinforce in a positive manner. Students should not be singled out as having given particularly "good" or "bad" answers. Each response should be taken as a point of departure for further discussion. The question "why" should be the dominant concern.

Some degree of structure in a discussion is necessary but structure should never hinder the flow of ideas. Probe questions can serve as the guiding structure, but they need not be taken in any order or progress in a stepwise fashion. For a given group of students some questions may stimulate more interest or controversy than others; the less fruitful questions, therefore, need not be pursued.

Promoting student to student interaction is another major role of the teacher, requiring insight and patience. The discussion process is an evolutionary one, often requiring much time before a definitive direction can be perceived. At times it may even appear that the discussion is circuitous, but it is imperative that each student has the opportunity to air his/her views and partake as an active member of the group. The student, when he/she becomes confident in himself/herself and recognizes the worth of his/her ideas, will then accept the responsibility of his/her role in the group as well as become more receptive to the ideas of others.

**Characteristics of Dilemma Discussion**

- *Open-ended approach:* There is no single "right" answer. The goal is not to reach agreement but to critically discuss the reasons used to justify a recommended action. The emphasis is on *why* some reasons may be more appropriate than others.
- *Free exchange of ideas:* Students should feel comfortable in expressing their thoughts. Each student should have an opportunity to contribute to the discussion within a non-judgmental atmosphere.
- *Student to student interaction:* The conversation is primarily between student and student, not teacher and student. The teacher uses questions to guide the discussion and to encourage students at adjacent stages of moral reasoning to challenge one another. Lecture or recitation should be avoided.
- *Development of listening and verbal skills:* Each student should be intimately engaged in the discussion activity, building and expanding on one another's ideas as well as examining each response critically.
- *Focus on reasoning:* Reasons are to emphasize the prescriptive "should" rather than the "would" arguments.
- *Dilemmas produce conflict:* Conflict heightens student involvement and interest and should have a personalized meaning for the student. Resolution of internal conflict is a precondition for advancement to higher stage reasoning.

**Helpful Hints**

- Review carefully the dilemma to be discussed in class and try to anticipate any problems that students might encounter when dealing with the dilemma.
- Identify the main issues and list a few questions that might help clarify the issues for the students (particularly, how these issues might relate to the students' lives).
- Determine if there are words or concepts that may be unfamiliar to your students. These should be defined and

discussed so that the students do not become overwhelmed by the terminology and can more easily grasp the essence of the problem.

• If you have readings which you feel are more pertinent or appropriate, use them in place of those included here.

• Consider whether or not the dilemma poses conflict for your students. It is often possible that the dilemma as written is either too sophisticated or too simplistic, and the students cannot appreciate the implicit conflict. The dilemma question might be reworded or altered in order to elicit a division of opinion among the students.

• When presenting the dilemma story make sure the students understand the problem and the goal of the discussion activity. This can be accomplished by having a student summarize the story and list some of the possible alternatives available to the main character(s).

• If a class is not accustomed to discussion-type activities, it might be wise to group the students in such a way that those who are more vocal and aggressive do not dominate or monopolize the discourse. Try to balance each group with different personality characteristics.

• When the discussion has difficulty getting started or gets bogged down, have the students role-play the main character. The shift in focus can assist them in gaining additional perspective into the situation.

• Try not to be too impatient if the discussion does not seem to go anywhere. As in any other type of group interaction, some warm-up time is necessary so that students can relax and reflect on their own thoughts.

• Students may continually look to you as teacher for direction and "correct" answers. When asked a question you can shift the attention by posing that question to another student and seek his/her opinion. In this way the dynamics of student interaction can be maintained.

• Tape recording some of the student dialogue may be useful as an evaluation tool to help organize future discussions and suggest additional probe questions.

• It is important that the discussion does not drift aimlessly or become a clash of personalities. Skillful interjection of probe questions will provide direction to the group discussion; therefore, become familiar with the different types of probe questions so that you can use them with fluency.

**Questions Commonly Asked**

• *In order to lead dilemma questions, do teachers need to identify the stage at which a student reasons?*

No, there is usually enough heterogeneity within a classroom so that several stages of reasoning are represented. Most important is to encourage different students to engage in the dialogue and to bring out the many different ways to resolve a problem.

• *What if everyone in the class takes the same position?*

This does not present any difficulty. The particular position taken is not important; what is important is the argument used to support the position. The different levels of reasoning on the dilemma should provide sufficiently lively debate. Students can also be asked to put themselves in the other position and develop arguments to support that position.

• *Should students be required to give reasons for their decisions?*

No, if reasons are not volunteered, you can simply ask another student to comment. The debate should not be forced but evolve naturally.

• *How does one detect student growth?*

Development is a slow process and a limited number of classroom dilemma discussions is not expected to advance students from one stage to the next overnight. However, students having experienced a diversity of alternative ideas should begin to develop an increasingly more global orientation and consider the different aspects of a problem.

• *Will a student reasoning at higher levels regress and accept the reasons of a more forceful lower stage argument?*

No, regression is not consistent with the stage theory. Persons reasoning at higher stages will see their argument reinforced as the discussion continues. Their reasons can deal more effectively with the question over a broader variety of situations; lower stage reasons begin to fall short. Studies have demonstrated that higher reasons are preferred over lower reasons.

• *How long does one continue the discussion?*

Discussion should continue for as long as it is fruitful and students continue to display a level of interest and involvement.

• *Is the object of the discussion to convince the class to accept higher level reasons?*

No. Simply "parroting" higher stage reasons does not effect or indicate growth. A stage reflects one's dominant mode of thinking on moral issues, one that is utilized. The purpose of the discussion is to provide new exposures and create a state of disequilibrium so that individuals begin to rethink and restructure. Discussion facilitates the course of development; it does not dictate it.

[1] Edwin Fenton, Ann Colby and Betsy Speicher-Dubin. *Developing moral dilemmas for social studies classes.* Cambridge: Harvard University, Moral Education Research Foundation, 1974.

[2] Barry Beyer. Conducting moral discussions in the classroom. *Social Education,* April, 1976, 195-292.

[3] Clive Beck. *Ethics.* Toronto: McGraw-Hill, 1972.

# Teaching Strategies And Student Activities

## Section One:
Technology And Change

## Activity 1: A Technology Inventory

**Overview**

How a new technological development impacts on a wide variety of activities is the focus of this activity. The intent is to help students recognize the widespread and extensive changes brought about by new innovations. Many of the effects are, of course, indirect effects, but indirect effects may in many cases produce the more profound changes and require significant shifts in existing institutions. The students will organize their ideas on the chart in Handout 1 and in this way create a visual summary of the dynamic factors that come into play. From this, they should gain an understanding that a new technology involves a system of new interactions and requires a complex support system in terms of knowledge, skills, resources and so on.

**Student Objectives**

- To examine a new technology as an interacting network of activities and resources (physical as well as human institutions).
- To gain an awareness of the dynamic changes that occur with technological developments.
- To consider some of the benefits as well as the dislocations brought about by new technologies.

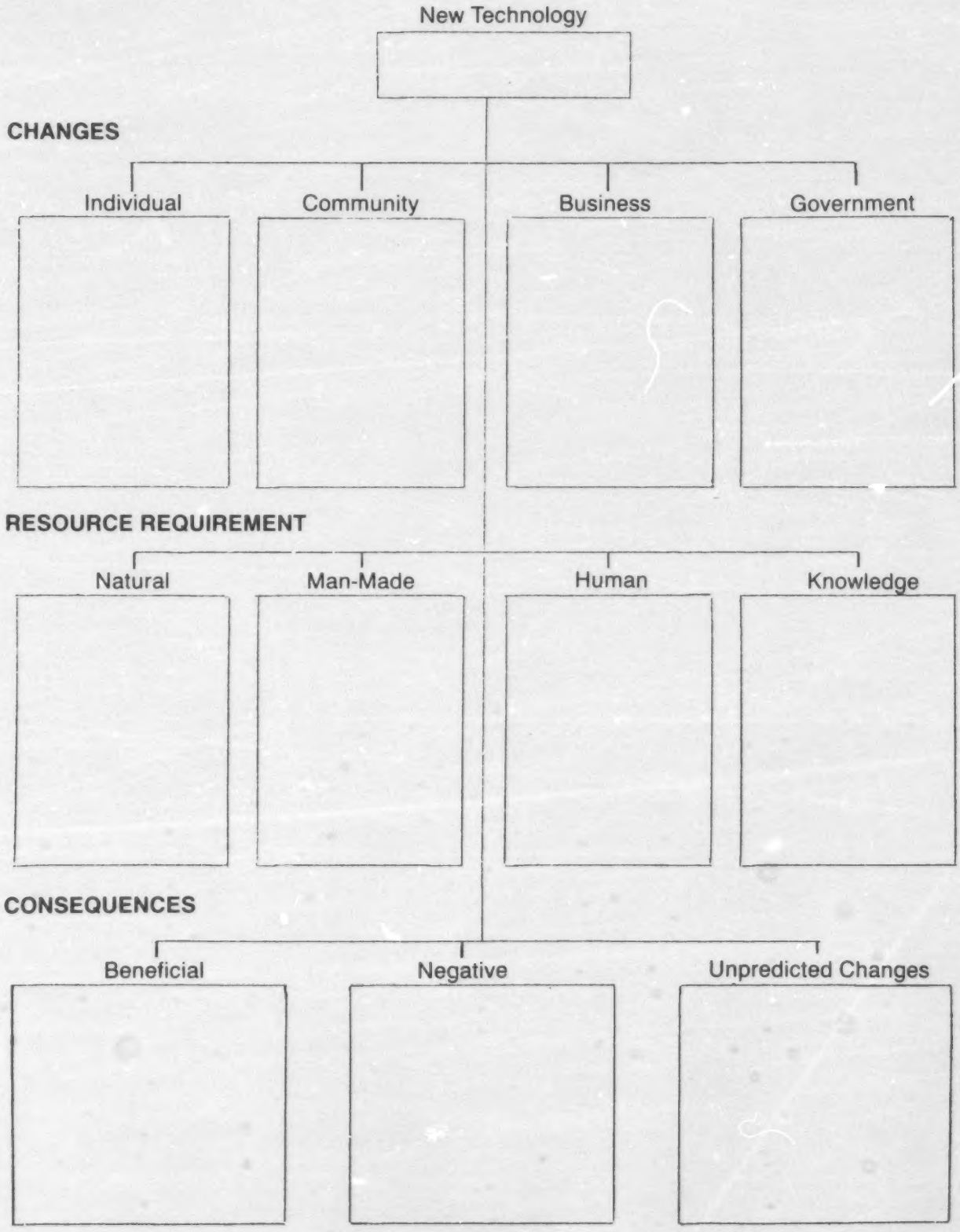
**Student Activities**

- Each student will receive a copy of Handout 1, *Technology Inventory*, and complete the chart using one of the technologies listed. The list is relatively short so that if there are other technologies students wish to examine, they should feel free to substitute others.
- Allow approximately one class period for the students to complete their charts, or have them complete the chart as a homework assignment. In either case, students need sufficient time to think about interactions that may not, at first, be readily obvious.
- Upon completion of the charts, students will meet in small groups to share their results. In the process of sharing ideas, new ideas will emerge, some of which students may wish to include in their charts. The questions at the end of the activity should be discussed in the groups.
- Undoubtedly, students will wish to hear the topics discussed in the other groups. Have representatives from each group present a summary report to the entire class. The class as a whole may then discuss some of major issues in greater depth.

**Comments and Suggestions**

- Students, for the most part, have given little thought to the societal and institutional changes brought about by a new technology and may find the assignment confusing or ambiguous. A detailed review of the example given will help to clarify their questions. Reproduce the chart on the board or overhead transparency and fill in the boxes with the students. The items for the categories *Resource Requirements* and *Consequences* have not been delineated and will need to be extracted from the narrative section of the example. As you progress through the example, students will inevitably begin to offer their own suggestions and discover that the task is not as formidable as they originally believed.
- Encourage the students to include as many ideas as they can possibly conjure. What may, at first glance, appear seemingly insignificant may from a longterm perspective have profound effects.
- An alternative to having students complete the chart individually is to have pairs or small groups of students complete a single chart. In the small groups the "brainstorming" technique is a useful technique to initiate the development of ideas. In brainstorming each item will be considered in turn. In a round robin fashion each student will present an idea. Each idea is recorded, and the process of presenting an idea continues until all ideas seem to be exhausted. The group as a whole will then evaluate the ideas and select those to be included. In some instances, several ideas may be combined to form a major concept.
- Students may need to be reassured that there are no single "right" answers to this exercise. Depending upon one's exposures, experiences or perspectives, one person's view about a given technology may be very different from that of another person. Try to help the students explore the ramifications of the technology by posing pertinent questions when students appear to reach an impasse.

## TECHNOLOGY INVENTORY



## Reading 1: The "Industrial Revolution" in the Home

**Overview**

We tend to think of technological advances in terms of devices to help us live more comfortably. Seldom do we consider the social changes that often accompany new technologies. One reason why this concept is perhaps difficult for many students to comprehend may be because their experiences with change are limited to only a short time interval. Hence, this reading which focuses on changes in the role of the housewife in the past century is one to which students can more readily relate. The point stressed is that application of our many new technologies requires of the user a greater diversity of skills as well a higher level skills. Where household tasks were once compartmentalized and performed by different individuals, they today are assumed by the housewife alone. She is a "Jack-of-many trades."

The reading also serves as background information to introduce Activity 2 which follows.

**Student Objectives**

- to gain an understanding of the interaction between technological innovation and social change.
- To recognize how technology has changed the role of the modern homemaker.

**Comments and Suggestions**

- After students have completed the reading, you may wish to extend some of the ideas brought out by the author in class discussion — the idea of self esteem (loss or gain) and the use of labor-saving devices, the advantages and disadvantages of mechanization, the creation of new household jobs, etc. You might also wish to explore future changes that home computers may create.
- This may be an opportune time to consider a much debated question surrounding technology: "Are technologies developed in response to human needs or are technologies inevitable products of new scientific knowledge?" That is, are we being conditioned to accept and change with new technologies, or do we choose and direct the course of technological developments? Consider some of our common everyday devices as examples: electric knives, can openers, microwave ovens, color televisions, clothes dryers, and so on.

## Activity 2: Technology and Changing Work Roles

**Overview**

This is a role play exercise where all students (male and female) are to take the perspective of a housewife and examine the skills necessary for managing a contemporary household. They take the role of a housewife seeking a position in the business world and write a resume for a job advertised in the Help Wanted Ads. From the resumes submitted, several are selected. The students whose resumes are selected will then role play the applicant at the job interview.

The purpose of such an exercise is to demonstrate that living in a complex scientific and technological world requires more sophisticated knowledge and competencies than in ages past. The proficiencies that are needed and acquired in running a modern household serve to illustrate the point.

As science and technology advance, the demands placed on the average person to become more knowledgeable may become even greater in the future. For example, the rapid development of the computer has already impacted on the way we make financial transactions. To read our "full-service" bank statements which contain the accounting of our savings, loan payments, bill payments and checking, has become a more complicated task, and to try to check the accuracy of the computing can boggle the mind of even a mathematician! Yet, to make informed choices about the foods we eat, the medications we take, or the mechanical devices we buy, requires a wide range of specialized understandings.

**Student Objectives**

- To become aware of the many skills required to function effectively in today's intricate modern world.
- To examine the many roles of a housewife from her perspective.
- To consider the different ways in which knowledge and competencies can be acquired.
- To gain an appreciation of the many demands and responsibilities that today's housewife encounters.
- To gain experience in writing a resume.

**Student Activities**

- Students will first respond to the Want Ad advertising for a corporate manager by writing a resume. This resume is to be written from the perspective of the role person described in the Student's booklet. The resume will summarize her job experiences.
- Two or three students will represent the "Personnel Department," review all the resumes, and select the three most effective ones.

- A student will role play the employer and interview the candidates whose resumes were selected. The purpose of the simulated interview is to provide an opportunity to further elaborate on the ideas students identified in their resumes. During the interview, the applicant will try to present convincing evidence in support of her qualifications. Also, the various techniques of interviewing can be explored. Allow approximately 10 minutes for each interview.
- A short class discussion should follow the role play to discuss some of the ideas that were presented. The discussion might also cover topics such as the growing trend of women entering the job market, changes in family living styles, how different types of technologies may be influencing the changes, the increase in adult education enrollments, schools which give college credits for "life experiences" in different subject areas, and the increase of job retraining programs.

**Comments and Suggestions**

- When introducing this activity to the class, it is important to emphasize that the purpose is *not* to determine whether a housewife of 16 years is qualified to assume a corporate position but to identify the diverse skills and knowledge that are acquired or developed in the course of managing a household. In many instances, some skills and knowledge are readily transferable, but other specialized knowledge is prerequisite depending upon the nature of the business.
- The boys in the class may feel uncomfortable role playing a housewife. Try to ease their apprehension — perhaps by having them think of the activity primarily as an exercise in resume writing and writing the most effective resume. The object of this particular role play is not so much to play a character part but to place oneself in the position of managing a household. Point out to the students that the task of maintaining a household is increasingly becoming the shared responsibility of husband and wife, when both work. Help the students get started by identifying some of the new types of tasks required of one living in a technological age. Also, the writers of resumes should remain anonymous until after the selection process. Remind the students *not* to write their names on the paper.
- Try to set the tone of professionalism in the activity to prevent the simulation from becoming a clash of personalities or cliché attacks on the routine aspects of housework. You may wish to use your discretion in selecting the students who interview the applicants.
- While three interview simulations have been recommended, the number may be adjusted accordingly, depending upon the different types of ideas that are revealed in the various resumes.
- If videotaping equipment is available, students may wish to videotape the interviews. Having to perform in front of a camera will increase the degree of preparation and professionalism students devote to the activity.
- Students may need additional guidance in resume writing and interview techniques. A brief review of the sample resume found in the student's booklet may prove useful.
- In the debriefing discussion, students may also wish to examine future family changes in light of the increase in dual career marriages. (The full-time housewife may soon join the endangered species list!) What technologies may be needed to assist in household management and maintenance? How might dual career parents share responsibilities and what new skills must each develop? Will life become more complex or simple? In what areas might formal training be increasingly important? What would help simplify the chores of a single-parent household?

## Reading 2: The Unseen Cost of Nuclear Power and the Faustian Bargain

**Overview**

The application of new technologies in many cases, if not most, involves "trade-offs." A most dramatic example of this issue is perhaps Dr. Alvin Weinberg's discussion on the "price" we must pay for nuclear power. He uses the analogy of the Faustian legend to illustrate his point. Where Faust sold his soul to the devil in exchange for worldly knowledge and power, we, in embracing nuclear power, have created new responsibilities that, Dr. Weinberg argues, may in fact require relinquishing our cherished value — freedom. This excerpt examines the societal trade-offs associated with nuclear technology and serves to introduce Activity 3.

**Student Objectives**

- To gain an understanding of the concept of "trade-off" in using new technologies.
- To examine the social consequences of a technology such as the generation of nuclear power.

**Comments and Suggestions**

- A number of abstract concepts are presented in this reading and may not be immediately obvious to the students. A short discussion following the students' reading may be important to determine whether they fully comprehend the focus of the article.
- In guiding the discussion, you may wish to examine some of the following ideas.
  - Review some facts about plutonium and its effects on biological systems.
  - Consider some of the suggestions for storing radioactive waste and the problems associated with each recommendation.
  - Consider the types of measures that may need to be enacted in order to protect the disposal site.
  - Dr. Weinberg speaks of a group of experts or a "priesthood" to oversee the use and safety of nuclear power. How will they be selected and how can human errors be averted?
  - Consider the "price" (societal, environmental) we pay for different technologies. Are the benefits worth the price? How might some of the costs be reduced or avoided?

## Activity 3: What Other Bargains? Technology, Consequences and Responsibilities

**Overview**

In this activity students, in small groups, will complete Handout 2, *Technology, Consequences and Responsibilities*. On this Handout is listed a series of six technologies and for each technology an undesirable effect is indicated. Students are to consider the types of new responsibilities that people must assume when they use the technology and list these responsibilities under the appropriate column. They will then suggest a solution that averts or remedies the undesirable effect.

**Student Objectives**

- To recognize the fact that unintended consequences are frequently associated with technological innovations.
- To identify new responsibilities associated with different technologies.
- To propose a solution that will safeguard against the undesirable consequence.

**Student Activities**

- Each student will receive one copy of Handout 2.
- Students will meet in small groups of 3 to 5 members to complete the worksheet.
- When the groups have completed the assignment, the class will meet as an entire group. At this time a spokesperson from each of the small groups will report on the group's conclusion.
- Following the presentations, the class will compare and contrast the different reports and discuss some of the issues that emerged. The questions at the end of the activity can serve to stimulate discussion.

**Comments and Suggestions**

- Background information about each of the technologies will provide students with greater insight about the topic. Although more commonplace technologies have been selected so that students are at least conversant on the subject, some additional research on their part will make the activity more interesting. One approach is to have the students find a recent news article that reports an incident related to the technology before they start discussing the assignment in the groups. For example, a number of problems on the disposal of toxic waste have created alarming news headlines. These problems include the Love Canal incident, fires and explosions at disposal sites, illegal dumping of wastes, the pollution of drinking water, and so on. Some aspects of the problem have been addressed by legislation such as the establishment of a "Super Fund" for toxic waste clean up. In this way, students will see the topic from a broader range of viewpoints as well as analyze some of the possible types of solutions.
- References which document some interesting case histories are *Technology and Social Shock* by Edward Lawless, published by the Rutgers University Press in 1977, and *Citizens and the Environment* by Lynton Caldwell, Lynton Hayes, and Isabel MacWhirter, published by the Indiana University Press in 1976.

## Activity 4: Technology and Knowledge

### Overview

The purpose of this debate activity is to impress upon the students the necessity for greater scientific literacy in order to live and function in a highly technological world. Moreover, as citizens in a democracy, they will be involved in making decisions on questions concerning the use of land and resources, waste disposal, product safety, distribution of health care and so on. These questions touch upon all aspects of their lives and involve concepts of a scientific and technological nature. In order to recognize problems inherent in such issues, deal with the multiplicity of interacting factors and voice their opinions knowledgeably, citizens will, therefore, need an understanding of science as well as more sophisticated problem solving skills. Yet scientific literacy is on the decline as the 1980 NSF report to the White House revealed. The findings show that the majority of students today are dropping science and mathematics earlier than in the past or taking fewer of those courses.

An educated citizenry, as Thomas Jefferson pointed out, is a prerequisite for an effective democracy. Will our democracy be in jeopardy if the education of its citizenry does not include an adequate science background? The debate question on whether the average citizen should serve on juries hearing cases of a technical nature serves to highlight the concern regarding effective citizen participation in the democratic process.

### Student Objectives

- To recognize the importance of an educated citizenry in a democracy.
- To conduct a class debate and learn effective debating techniques.

### Student Activities

Students will prepare for and conduct a debate using the format outlined in the student booklet or another suitable type of debate format.

Activity 3:

## TECHNOLOGY, CONSEQUENCES AND RESPONSIBILITIES

| Technological Innovation | An Undesirable Effect | New Responsibilities for People | Possible Solutions |
|---|---|---|---|
| Tape Recorders | Illegal copies of tapes are reproduced and sold by "tape pirates" | | |
| Weather modification such as cloud seeding and hurricane control | Hurricanes are diverted from one's own country and sent over another country (perhaps to an unfriendly neighbor?) | | |
| Automobiles | Car exhaust fumes create smog which cause lung diseases and even death | | |
| Computerized Banking | Thieves who discover your bank number draw money out of your account | | |
| Airplanes | Terrorists skyjack airplane for ransom | | |
| Plastics | Production of plastics create toxic waste products that are difficult to safely dispose. | | |

*DEBATE QUESTIONS*

*The jury system should be abolished on cases involving technical questions because the average citizen is not qualified to make decisions on issues requiring highly technical knowledge. Instead, cases should be decided by panels of specialists who have expertise in the areas of the case.*

- Have the students read the debate question and allow them to select sides. There should be an equal number of students on each side. Three students are selected to serve as judges. However, if at all possible, it is suggested that the three judges be persons from outside the class. (This is a good opportunity for school administrators or people in the community to observe the class debating a controversial topic.)
- Each team will meet to identify the major arguments that support its position. They should read the two articles (Reading 3 and Reading 4) before they begin. The readings provide insight on the question as well as cite the advantages and disadvantages of the existing system. The number of major arguments identified should equal the number of members on the team. In this way, each team member will have one argument to develop for the debate. Two copies of the list of arguments are made.
- Each team exchanges a copy of its arguments with the other team. Team members then select an argument from the team's own list and an argument from the other team's list. Each debater is thus responsible for preparing a presentation in support of his/her position and a rebuttal to the other team's argument.
- Students should have approximately two days (either in class or as a homework assignment) to do some outside research and prepare their presentations.
- During the debate, one judge will serve as the presiding judge and one will serve as a timekeeper. Although a three-minute speech has been suggested, you may wish to extend or reduce the time limit based on your experience and knowledge about the students' level of interest and capabilities.
- Teams will alternate in presenting their arguments and rebuttals until all the presentations are heard. Judges will evaluate the debaters using a score sheet similar to the one shown in the students' books. Following the individual arguments, a member from each team will give a summation speech, approximately 5 minutes in length, reiterating the major issues addressed by the team.
- The judges will then tally up their scores and announce the decision.
- It is important to devote some time to debrief the debate. One type of debriefing strategy is to proceed from a discussion of specific elements of the debate (i.e., reasons why one team was more effective, debating style, types of persuasive techniques employed, facts used to support an argument and so on) to the more global concepts entertained during the debate. The questions at the end of the activity offer some additional ideas for discussion. The debriefing serves a number of purposes:
  - It permits students to express their feelings about the activity.
  - It serves to identify methods for improving the debate.
  - It is an evaluation exercise.
  - Students can reflect on and further discuss some of the ideas brought out during the debate. During the heat of the debate, some ideas may not have been completely investigated.

**Comments and Suggestions**

- If your students have had little debating experience, it will be useful to offer some pointers for effective debating prior to the activity. One important strategy that should be stressed is the use of facts/evidence to support one's argument and the logical development of that argument.
- Each team should also have an opportunity to practice its presentation before the actual debate. Constructive criticism by team members will improve performance. Moreover, this will be a good way to make sure the arguments are not redundant nor exceed the time limit.
- If the class is large or if time is at a premium, the number of arguments may be reduced in half. Half the team will then be responsible for presenting the team's argument while the other half will present the rebuttals.
- Since the judges do not actively participate in the debate preparations, they may be at a loss for something to do. You may suggest that they do some research on the judicial system and compile some recommendations for its improvement. This set of recommendations is presented at the end of the debate for the class to evaluate.
- For the debate, classroom furniture should be arranged in such a way that team members are seated together. This permits team members to consult with one another as the debate progresses. When opposing arguments are heard, a debater may find the need to modify his/her presentation by emphasizing certain ideas and minimizing others. This arrangement will also make it easier for the judges to identify and call upon debaters from each team.

# Teaching Strategies And Student Activities

## Section Two

Emerging Technologies

**Overview**

This section examines five technologies and some of their possible uses and application. Each topic is introduced with readings, followed by a dilemma for class discussion. Each dilemma raises concerns about the wise use of the technology. While a technology is feasible from a scientific and technological standpoint, the questions about whether or not it *should* be employed must also be addressed. It is socially acceptable? The point to be made is *not* that the technology is in any way malevolent but that human ambition, greed and even ignorance can lead to its abuse. Moreover, our modern technology has endowed us with once undreamed of powers, capable of changing the evolutionary process and even the very nature of human beings. The potential of new innovations offers important opportunities, but the consequences and implications of the change will need to be carefully examined. Some examples of value conflicts in the form of dilemmas are presented to stimulate students to think about societal issues arising from the various technologies.

The topics included in this section are

- Mind and Mind Control Research
- Genetic Engineering
- Remote Sensing
- Computers and Artificial Intelligence
- Solar Power

**Student Objectives**

- To increase students' awareness of societal issues associated with the application of new technologies.
- To challenge students to think critically about the impact of technology on society.
- To engage students in the discussion of moral/ethical issues that interface science, technology and society.

**Student Activities**

- Have the students read the introductory articles before they meet to discuss the dilemma.
- Follow the procedure for conducting dilemma discussions as outlined on pages 13 to 17 of this guide.

**Comments and Suggestions**

- The dilemmas in this section follow no sequential order and therefore may be presented in whatever order you choose. Some teachers have found it desirable to alternate dilemma discussions with other ongoing classroom activities to provide a change of pace.
- Use your discretion in determining the amount of time you wish to devote to a given discussion. Typically, one class period is sufficient time. However, some issues evoke more controversy, and students have continued the discussion over a period of days and sometimes even into their other classes, hallways or cafeteria. There may also be times when students desire to do additional research or readings on the topic and should be encouraged to do so.
- Use of other discussion formats can provide some diversity to the suggested discussion procedure. The following are some ideas that have been successfully employed and which students have found enjoyable:
  - — Assign the dilemma to be read for homework and have the students respond to one of the questions in writing. This procedure allows time for the students to reflect on the issue and organize some of their ideas before the discussion.
  - — Have each student interview a person outside the class to obtain his/her response to the dilemma question. In this manner, additional viewpoints on the issue can be presented in the class discussion.
  - — Dilemmas have served as the topic for a "mock" trial or class debate. These formats often require additional research and more tightly developed presentations.
  - — Role play scripts have been developed from the dilemmas and are an interesting way to present the issues in conflict. Role play offers students a good opportunity to more intimately take the perspective of another person. As mentioned in earlier sections of this guide, role taking is an important element in cognitive and affective development.
  - — Have students write or enact a scenario depicting the consequences of one and the other response to the dilemma question. This strategy encourages students to evaluate the different implications of the situation. Students in this activity will be answering for themselves the "what if . . .?" questions.
  - — Videotape a class discussion and show it to another class. Have the students respond to the comments made by the first class. This technique provides a good opening introduction to stimulate discussion.
  - — Have students write their own dilemmas on the same issues and present them for class discussion. Writing a good dilemma that evokes heightened controversy is a task that challenges their creativity and requires insightful introspection about the issues in conflict.
- You will find that some dilemmas stimulate more discussion while others appear not to evoke much response. For the seemingly less controversial dilemmas, asking the main question in a slightly different way may help promote student reponses. One reason why some dilemmas appear to generate less controversy is because students do not fully understand the nature of the issues in conflict. Some issues may in fact be more sophisticated and are not comprehensible to students who are reasoning at lower cognitive levels. Therefore, it is important to first determine that the students understand the dilemma before they begin their discussion. This can be accomplished by asking a student to restate the problem in his/her own words, then inquire if the other students agree with the interpretation.

# Teaching Strategies And Student Activities

## Section Three
Future Technologies

# Activity 5: Technology and Decision Making: A Technology Assessment Simulation

**Overview**

Government officials as well as the public have acknowledged, in recent years, the important need to recognize adverse effects of technologies before they become widely instituted. How to avert potential catastrophies and unpleasant side effects is a difficult challenge because there are so many unknowns. We would all welcome an accurate "crystal ball" which forecasts all future effects! But given that "crystal balls" are beyond our grasps, we have begun to develop methodologies for evaluating potential impacts of technologies. Such evaluation techniques fall under the rubric of "technology assessment." The purpose of technology assessment is to provide decision makers and policy makers with a broad information base to help them make wise judgments. Technology assessment involves systematic gathering of information using a variety of techniques, input from experts from various disciplines, evaluating different options and organizing the information in a useful manner. The focus is not only on direct consequences but on higher order consequences such as effects on people, social organizations, institutions and the physical environment. In a sense, technology assessment is a societal impact statement that examines how a technology might influence social, legal, political, economic and educational sectors. It provides data for decision making so that people can better select directions for the future.

In this activity students will evaluate some future activities using some of the considerations that entertained in the technology assessment process. Typically, the techniques used include technological forecasting, cost benefit and benefit risk analysis, system analysis, modeling and other types of futures forecasting methodologies. Such sophisticated assessments are time consuming and are, naturally, well beyond the scope of high school classes. While the technical aspects of assessment methodologies are quite complex, students can at least begin to identify and think about how a new technology might influence, affect or change our existing society. The intent of this simulation is thus to challenge students to search for possible impacts of a new technology that may be unintended, indirect or delayed, producing unpleasant side effects. Equally important is identifying possible changes so that people can prepare to make necessary adjustments or appropriate responses to a new technology in order to obtain its maximum benefits.

Students will work in one of four interest groups and assume the role perspective of that group. They then select from a list of future technologies those which will best promote the goals of their group. Using the technology assessment flow chart, they will examine each technology and its impact on the areas listed. Based on the assessment, the group will select four to submit to the World Review Court for final evaluation. To complete the activity the students will write a scenario describing a world of the future where the "court approved" technologies have been instituted.

**Materials**

- Handout 3, *World Review Court Evaluation Sheet*
- Handout 4, *Technology Assessment Worksheet*

**Student Objectives**

- To participate in a simulated decision making activity.
- To identify and evaluate technological impacts from a broad societal and environmental perspective.
- To project into the future and examine alternative options.

**Student Activities**

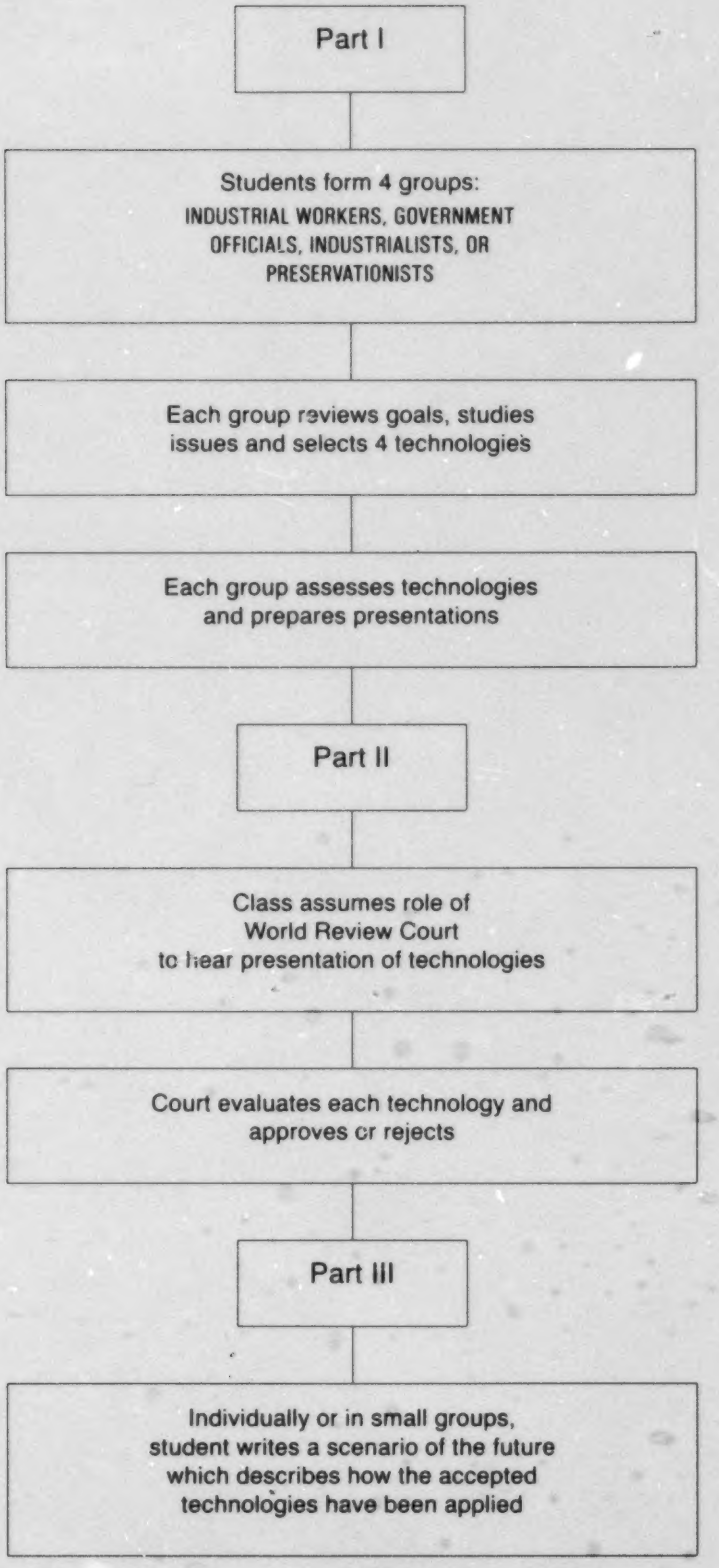
This simulation activity is divided into three parts:

Part I — Group Preparation
Part II — World Review Court Hearing
Part III — Discussion of Results and Scenario of the Future

Diagram 1 is a flow chart which describes the activity sequence.

**DIAGRAM 1**

## SIMULATION PLAN


Part I
Students form 4 groups:
INDUSTRIAL WORKERS, GOVERNMENT OFFICIALS, INDUSTRIALISTS, OR PRESERVATIONISTS
Each group reviews goals, studies issues and selects 4 technologies
Each group assesses technologies and prepares presentations
Part II
Class assumes role of World Review Court to hear presentation of technologies
Court evaluates each technology and approves or rejects
Part III
Individually or in small groups, student writes a scenario of the future which describes how the accepted technologies have been applied

## TECHNOLOGY ASSESSMENT WORKSHEET

What needs influence the development of the technology?

What are the components of the technology?

Who will control the technology and who will benefit from it?

Technology _____

Give an example of its use _____

_____

First order consequence – What is the intended effect(s)?

Second order consequences – What effects are related to the technology?

Higher order consequences – What broad changes will occur?

Impacts on Other Areas

Individual Health and Safety

Natural Resources

Energy Needs

Family Life

Waste Disposal

Environment

Government and Laws

Workplace

Industry

Community

Business

## Figure 1: An Example

### TECHNOLOGY ASSESSMENT WORKSHEET

**What needs influence the development of the technology?**
- farm land decrease
- population increase

**What are the components of the technology?**
- advanced fishing gear
- underwater sensors
- new food processing techniques
- ocean factories, electronic traps

**Who will control the technology and who will benefit from it?**
- ocean farming comprises control nations

**Technology** Ocean farming

**Give an example of its use** Cultivating plankton and other small plants and animals and raising fish under controlled conditions (fish farming)

**First order consequence – What is the intended effect(s)?**
Increase world food production significantly

**Second order consequences – What effects are related to the technology?**
- reduce malnutrition - population increase
- new types of food products - eating habits change
- inland nations are at a disadvantage

**Higher order consequences – What broad changes will occur?**
need for greater cooperation among nations regarding use of seas - world sea court to resolve disputes - form international companies to farm oceans.

**Impacts on Other Areas**

**Individual Health and Safety**
- less starvation
- improved diets

**Natural Resources**
- habitat of existing sealife may be disrupted
- some species become extinct

**Energy Needs**
- reduce need for petroleum to produce fertilizer

**Family Life**
- father spend months out at sea
- change in dinner menus

**Waste Disposal**
- waste from the factories need to be treated properly

**Environment**
- coast becomes more crowded
- natural food chain may be disrupted

**Government and Laws**
- disputes among nations over who had rights to use the oceans

**Workplace** - more jobs for fisherman and marine biologists
- reduce unemployment
- dangers of violent storms

**Industry**
floating factories at sea

**Community**
- people move to coastal towns to be close to jobs

**Business** greater demand for seafood products
- enlarge fishing fleets
- boom in boat building

## Part I — Group Preparation

- Students will work together in one of four groups:

  industrial workers,
  government officials,
  industrialists, or
  preservationists

  Based upon your understanding of the students, you may wish to randomly assign students to groups or allow them to select their groups. However, the groups should be evenly distributed.
- Review the different steps of the simulation so that everyone understands the purpose and task. Have the students examine Diagram 1 which outlines the sequence of events. This is also a good opportunity to review the completed example (Figure 1) so that students' questions about the task can be answered before they begin. Each student should receive a copy of Handout 3.
- In their groups, students should first read *Forty-One Future Problems* and *An Agenda for the 1980's*. The readings point out areas of future concern and will assist students in identifying technologies which may help promote their goals.
- Each group should begin with a discussion of its goals so that all group members will share a common understanding. They should then compile a list of issues or "problems to be solved." This list thus serves as a guide in helping the group identify technologies related to its goals.
- From the list of Future Technologies the group members will make their selection. Since the list is rather lengthy, the members may wish to divide the list and have different members study the various sections. Since some technologies will be discarded after the assessment, a number greater than four should be selected. A good strategy is to rank order those selected in their order of importance and then evaluate each in turn. When four technologies have been selected, those items remaining need not be further considered.
- The members may wish to conduct the assessment and fill in the worksheet as a group or individually. There are advantages to both methods, and to a large extent, the preference for one or other method may depend upon the size of the group. However, having several students provide input facilitates the development of more ideas.
- After the assessments are completed and group members have agreed upon the four (4) proposed technologies, each group develops a five (5) minute report for each technology to be presented orally before the World Review Court. This report is essentially an argument in support of the technology and should demonstrate the beneficial changes that will result if the technology were adopted. Information from the completed worksheets provide the basic concepts which are further elaborated upon in the report.
- Allow approximately two to three class periods for the students to complete this portion of the simulation.

## Part II — World Review Court Hearing

- At the designated time the class will convene as the World Review Court. One student will serve as the presiding judge, responsible for maintaining order and calling upon presenters in turn. He or she should also be assisted by a timekeeper who ensures that the presentation does not exceed the time limit.
- The students must now assume their role as World Court Judges. Except for the time when they make their presentations as representatives of an interest group, they must take the role of impartial judges who are responsible for the well-being of the world-at-large. They will undoubtedly experience internal conflict because they are promoting their own proposal and at the same time must experience their objective judgment. In many respects, this is not unlike situations encountered by members of Congress or other elected officials who must respond to the special needs of their constituency who elected them, as well as consider national needs and policy. Try to impress upon the students the importance of their role as judges and challenge them to stretch their critical thinking abilities.
- Each student receives a copy of Handout 4, *World Review Court Evaluation Sheet*. On it are a list of "objections" which they should consult periodically during each presentation. On the reverse side is a table for recording the results. It may be useful to review with the class the list of objections and cite an example for each objection. This will help the students to better understand the meaning and implication of those objections.
- The four interest groups will, in a rotating sequence, present their technologies before the World Review Court. Following each report, the judges have an opportunity to cite an objection. Each objection must be accompanied by an explanation as to why the technology is undesirable or potentially dangerous. The Court as a whole will then vote on the acceptability of the objection. Technologies which receive two objections are eliminated.
- After all presentations are heard and evaluated, the technologies meeting the Court's approval are announced by the presiding judge. The interest group with the greatest number of technologies accepted is declared the group that has successfully achieved its stated goal.

## WORLD REVIEW COURT EVALUATION SHEET

### Objections

The new technology will:

1 — Violate individual freedom and freedom of choice
2 — Cause irreparable damaging change to the environment of human life
3 — Create overcrowding and widespread famine
4 — Create large scale unemployment
5 — Invade personal privacy
6 — Produce dangerous waste products
7 — Enable government to make more of our personal decisions
8 — Produce conflict between nations and increase likelihood of global warfare
9 — Increase the gap between the rich and the poor nations
10 — Drain nonrenewable natural resources
11 — Create economic instability as a result of government overspending
12 — Increase social unrest and conflict by widening the gap between the rich and poor
13 — Increase competition among nations for scarce resources
14 — Produce situations where people feel alienated, useless or a lack of control over their own lives
15 — Leads to "Big Brotherism" — government increases the monitoring of its citizens
16 — Reduces the value of human life and human dignity

**Instructions:**

- Record the title of the new technology presented and the name of the group sponsoring it. During the presentation, you are to decide whether or not the technology will create/cause any of the objections listed above.
- Try to think of different ways in which the technology might be used. Ask yourself the questions: "What might happen if the technology were used or controlled by an unscrupulous person or group?", "What might happen if it were used in ways other than its intended purpose?", or "Will it create unresolvable problems for future generations?"
- When the presenter is finished, you, as judges, may in turn, cite an objection. Record the number of the objection in the box next to the title. The entire panel of judges will then vote on that objection: *Yes* — if they agree with the objection, *No* — if they disagree with the objection. Record the number of *Yes* votes and *No* votes. Other objections will be made and voted upon in a similar manner. Do this until all objections are heard. A technology which produces *two* or more objections will be eliminated. Therefore, if the judges agree upon two objections, it is unnecessary to hear any additional objections. Proceed to the next technology until all 16 technologies have been heard and evaluated.

## RECORD SHEET

| Technology | Name of Group | Objection Number and Record of Vote | | | | |
|---|---|---|---|---|---|---|
| 1 | | Yes / No | Yes / No | Yes / No | Yes / No | Yes / No |
| 2 | | Yes / No | Yes / No | Yes / No | Yes / No | Yes / No |
| 3 | | Yes / No | Yes / No | Yes / No | Yes / No | Yes / No |
| 4 | | Yes / No | Yes / No | Yes / No | Yes / No | Yes / No |
| 5 | | Yes / No | Yes / No | Yes / No | Yes / No | Yes / No |
| 6 | | Yes / No | Yes / No | Yes / No | Yes / No | Yes / No |
| 7 | | Yes / No | Yes / No | Yes / No | Yes / No | Yes / No |
| 8 | | Yes / No | Yes / No | Yes / No | Yes / No | Yes / No |
| 9 | | Yes / No | Yes / No | Yes / No | Yes / No | Yes / No |
| 10 | | Yes / No | Yes / No | Yes / No | Yes / No | Yes / No |
| 11 | | Yes / No | Yes / No | Yes / No | Yes / No | Yes / No |
| 12 | | Yes / No | Yes / No | Yes / No | Yes / No | Yes / No |
| 13 | | Yes / No | Yes / No | Yes / No | Yes / No | Yes / No |
| 14 | | Yes / No | Yes / No | Yes / No | Yes / No | Yes / No |
| 15 | | Yes / No | Yes / No | Yes / No | Yes / No | Yes / No |
| 16 | | Yes / No | Yes / No | Yes / No | Yes / No | Yes / No |

## Part III — Discussion of Results and Scenario of the Future

- As with the previous debate activity, some time should be spent debriefing the simulation. The general debriefing guidelines presented for that earlier activity can be followed. Also, the discussion questions on page 112 in the student's booklet can provide a starting point for discussing the results of the simulation.
- Following the simulation, the students will write a scenario of the future describing a world where the selected and approved technologies have been instituted. The scenario may be written individually or in small groups as a homework assignment. In writing the scenario, students will need to organize some of their own ideas developed during the course of the simulation and explore their thoughts about how the various technologies might influence future events. This writing activity challenges students to make projections about future changes brought about by the new technologies and to include their personal commentary about those changes. While they have been evaluating technological impact throughout the simulation, the scenario provides a format for students to evaluate the final decisions they made.
- In the scenario the students will answer the question "How will the future be affected by the decisions we made?" The technologies selected will be examined from a broader prospective and in terms of how one technology interacts with another. Scenario writing is, in fact, a methodology used by future forecasters to explain or explore a future forecast. By developing a story or narrative around a series of possible events or desired goals, one can begin to examine the complex interactions of factors and variables of that situation. It provides a flexible format for the writer to consider possible changes, consequences, and interrelationships in a more holistic manner. In this particular scenario writing exercise, the students will be making predictions about future changes and identify ways in which society prepares for and responds to those changes. This will enable students to gain additional insights about technology and change.

**Comments and Suggestions**

- The list of "Technological Innovations" given contains a number of technologies that are, of course, unfamiliar to most people. Students will need to learn more about the technologies and the uses. Hence, allowing sufficient time for students' research is important because the increased knowledge will help to make the assessment task easier as well as make the simulation more interesting. The amount of time to be devoted to research is best determined by you and your knowledge of the students' needs and interest.
- We intentionally retained most of Herman Kahn's list of "100 Technological Innovations Very Likely in the Next Twenty Years" to provide an overall view of future possibilities entertained by a future specialist. As a result, some of the items are very specific while others are very general in nature. Students will, therefore, need to make their own interpretations about the scope of the innovation and its forms. They will also need to apply their judgment skills in selecting what they believe to be more significant breakthroughs.
- There are no prescribed time limits for the group meetings. However, a flexible schedule should be established to provide students with a guideline of tasks to be accomplished. For example:

**Day 1: 1st group meeting**

— Based on what they learned from the readings, students will identify problems that need to be solved in order to attain the group's goals.

— A preliminary list of technologies is selected for investigation by the group members.

**Day 2: Independent research by student**

**Day 3: 2nd group meeting**

Students report their findings and select four (4) for the technological assessment. Begin the technological assessment.

**Day 4: 3rd group meeting**

Continue technological assessment and complete. Prepare reports for presentation to the World Review Court.

(It may be advisable to leave some time interval between the scheduled group meetings and the World Review Court proceedings. Some groups may need additional time and perhaps can complete their tasks outside of class.)

**Day 5 and 6: World Review Court proceedings and debriefing of simulation.**

**Day 7: Scenario Writing**

**Day 8: Presentation of some of the student scenarios**

# A Selected Bibliography: Science, Technology And Society


A. SCIENCE, TECHNOLOGY AND SOCIETAL IMPACT

Burke, James. *Connections.* Boston, MA: Little, Brown & Co., 1978.

Burke, John and Marshall Eakin (eds.) *Technology and change.* San Francisco: Boyd and Fraser Pub. Co., 1979.

Dorf, Richard. *Technology and society.* San Francisco: Boyd and Fraser Pub. Co., 1974.

Dorf, Richard and Yvonne Hunter (eds.) *Appropriate visions: technology, the Environment and the Individual.* San Francisco: Boyd and Fraser Pub. Co., 1978.

Drucker, Peter F. *Technology, management and society.* New York: Harper and Row, 1970.

Lawless, Edward W. *Technology and social shock.* New Brunswick, N.J.: Rutgers University Press, 1977.

Morison, Elting E. *Men, machines and modern times.* Cambridge, MA: MIT Press, 1966.

Pytlik, Edward, Louda, Donald, and David Johnson. *Technology, change and society.* New York: Davis Publishing (Div. of MacMillan), 1978.

Snow, C.P. *The two cultures: and a second look.* Cambridge: Cambridge University Press, 1964.

B. SCIENCE, TECHNOLOGY AND VALUES

Baier, Kurt and Nicholas Rescher. *Values and the future: the impact of technological change on American values.* Santa Cruz, CA: Free Press, 1969.

Calder, Nigel. *Spaceships of the mind.* New York: Viking Press, 1978.

Conboy, William A. (ed.) *The challenge of the future: visions and versions.* Lawrence, Kansas: The University of Kansas, 1979.

Ellul, Jacques. *The technological society.* New York: Knopf, 1964.

Ferkin, Victor. *The future of technological civilization.* New York: Braziller, 1974.

Garlan, Patricia and Maryjane Dunstan. *Star sight.* Englewood Cliffs, N.J.: Prentice Hall, 1977.

Goldpaster, K.E. and K.M. Sayre. *Ethics and problems of the 21st century.* Notre Dame, Indiana: University of Notre Dame Press, 1979.

Schumacher, E.F. *Small is beautiful: economics as if people mattered.* New York: Harper and Row Pub., 1973.

Watkins, Bruce and Roy Meader. *Technology and human values.* Ann Arbor, Michigan: Ann Arbor Science Pub., Inc., 1977.

C. SCIENCE, TECHNOLOGY AND THE FUTURE

Bundy, Robert (ed.) *Images of the future.* New York: Prometheus Press, 1976.

Cornish, Edward. *The study of the future.* Washington, D.C.: World Future Society, 1977.

Dertouzos, Michael L. and Joel Moser (eds.) *The computer age: a twenty-year view.* Cambridge, MA: MIT Press, 1979.

Ellison, Craig W. (ed.) *Modifying man: implications and ethics.* Washington, D.C.: University Press of America, 1977.

George, Frank. *Machine takeover: the growing threat to human freedom in a computer-controlled society.* Oxford, England: Pergamon Press, 1970.

Grobstein, Clifford. *A double image of the double helix: the recombinant—DNA debate.* San Francisco: W.H. Freeman & Co., 1979.

Harmon, Willis. *An incomplete guide to the future.* Palo Alto, CA: Stanford University Press, 1976.

Martin, James. *The wired society.* Englewood Cliffs, N.J.: Prentice Hall, 1979.

McCorduck, Pamela. *Machines who think: a personal inquiry into the history and prospects of artificial intelligence.* San Francisco: W.H. Freeman, 1979.

McHale, John. *Changing information environment.* Boulder, CO: Westview Press, 1976.

Moser, Leo J. *The technological trap: survival in a man-made environment.* Chicago, Ill.: Nelson-Hall, 1979.

Rosen, Stephen. *Future facts: a forecast of the world as we will know it before the end of the century.* New York: Simon and Schuster, 1976.

D. DECISION MAKING IN A TECHNOLOGICAL AGE

Basiuk, Victor. *Technology, world politics and American policy.* New York: Columbia Univ. Press, 1977.

Braun, Ernest, Collingridge, David and Kate Hinton. *Assessment of technical decisions — case studies.* Woburn, MA: Butterworth, 1979.

Hill, Percy H. *Making decisions: a multi-disciplinary introduction.* New York: Addison-Wesley, 1979.

Koberg, Don and Bagnell. *The universal traveler — a soft systems guide to: creativity, problem solving and the process of reaching goals.* Los Altos, CA: William Hoffman, Inc., 1976.

Martino, Joseph. *Technological forecasting for decision making.* New York: American Elsevier, 1972.

Nelkin, Dorothy (ed.) *Controversy: politics of technical decisions.* Beverly Hills, CA: Sage Publications, Inc, 1979.

Teich, Albert (ed.) *Technology and man's future.* New York: St. Martins Press, 1977.